POWER PLANT ENGINEERING

Established Over 33 Years

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The Ethiopian Conveyor System

DESIGNED ESPECIALLY for conveying materials used in erecting boiler settings, power plant buildings and similar structures, the Ethiopian Conveyor System, shown in the accompanying illustration, has recently been placed on the market. It is shown in operation in the erection of a large power plant below the Mason and Hamlin line. The conveyor consists essentially of a series of units, each one mounted on two pedal extremities usually known as the "dawgs." On the head of each unit is placed a quantity of material to be transported, such as a neat cluster of about 36 fire brick or even, mayhap, a pail of mortar. Then, by appropriate shuffling motions of the "dawgs," the Ethiopian Conveyor is propelled towards the job.

Maintenance of this conveyor, it is stated by the promoter, is extremely low. The only parts subject to wear are the "dawgs," it is claimed, since the load is transmitted directly through the heads of the units to the "dawgs" without wear on the heads. By supplying the conveyor with suitable quantities of lubricant and po'k chops and by allowing the Ethiopian units to remain motionless in the sun for about three hours each day, the promoter states that the life of the conveyor can be prolonged for many years at extremely low cost.

Complete details regarding the capacities and sizes of the Ethiopian Conveyor can be obtained from The Aframerican Engineering, Construction and Financing Corp., 2100 East Magnolia St., Birmingham, Ala.

Power, Lighting and Heating demands of the

RAYON INDUSTRY
Must Be Met by
MODERN POWER PLANTS

H. A. KULJIAN, *Chief Engineer*
The Viscose Co., Marcus Hook, Pa.

POWER PLANT OF THE VISCOSE CO. AT PARKERSBURG, W. VA., IS AN EXCELLENT EXAMPLE OF MODERN BOILER AND TURBINE ROOM DESIGN AND FLEXIBLE ARRANGEMENT DEMANDED BY THIS RAPIDLY GROWING INDUSTRY.

IN SUCCESSFUL OPERATION for a sufficient length of time to prove its capacity for fulfilling the exacting needs of this industry, the Parkersburg, W. Va., power plant of the Viscose Co. is laid out so the boiler house can be doubled in capacity, without any additional coal or ash handling equipment, by adding four more boilers. The generator room is also designed so that additional generating units can be installed with proper electrical switchboards to correspond with the boiler house additions.

The coal and ash handling system is shown in Figs. 3 and 4 with a track hopper and reciprocating hopper at A, inclined apron feeder at B, double roll crusher at C, bucket elevator at D and distributing flight conveyor at E. This 100-t. per hr. system is designed so that at present it is operated only four hours a day but when the plant is completed it will be operated eight hours a day. The capacity of the coal bunker in the power house is 1800 t. or about four days storage capacity for a maximum amount of steam generation during the winter, when only four boilers are in operation. Each ash hopper under the boiler setting has a 24-hr. capacity when completely burning 8 per cent ash coal. The capacity of the ash storage hopper is 6500 cu. ft., or four days for four boilers.

Shown in Fig. 5, the boiler setting is typical for the four boilers. It has a furnace volume of 5000 cu. ft. which gives 25,000 B.t.u. heat liberation per cu. ft. when the boiler is operating at 90,000 lb. steam per hour. The projected grate area of the stoker is 206.56 sq. ft., (including the single roll clinker grinder) and will burn 44 lb. of coal per square foot projected area per hour. The coal now used has an ultimate analysis as shown in the table. These furnaces have a deflecting bridge wall, also two side walls and a front wall, the lower portions of which are equipped with air-cooled carborundum blocks. The upper portion of the furnace is set with first and second-class fire brick as indicated in the sketch.

Under each stoker, the plenum chamber is made up from reënforced concrete and sloped so that the sifted coal can be removed by opening the grates and dumping. The damper between the plenum chamber and forced draft air duct can be operated either manually or automatically to give the proper amount of air required for combustion.

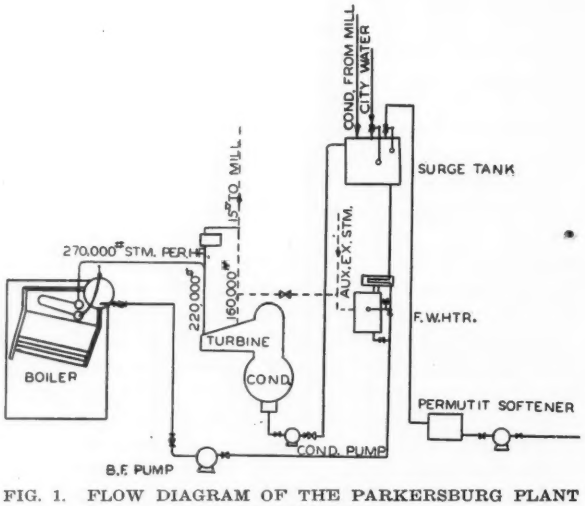


FIG. 1. FLOW DIAGRAM OF THE PARKERSBURG PLANT OF THE VISCOSE CO.

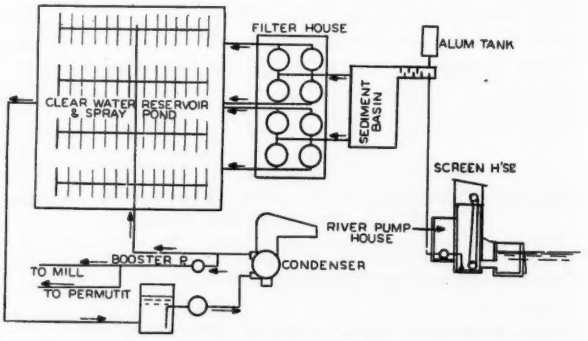


FIG. 2. IN THE WINTER TIME THE MILL SUPPLY WATER IS PASSED THROUGH THE CONDENSER

either bypass the air heater or take flue gas from each heater and discharge it through a common flue, into a stack 225 ft. high above the boiler room floor and 12 ft. 6 in. in diameter at top. Each induced draft fan is equipped with a slip-ring motor and a resistor to vary the speed of the fan from a handwheel located at the boiler room floor. Each boiler is equipped with steam

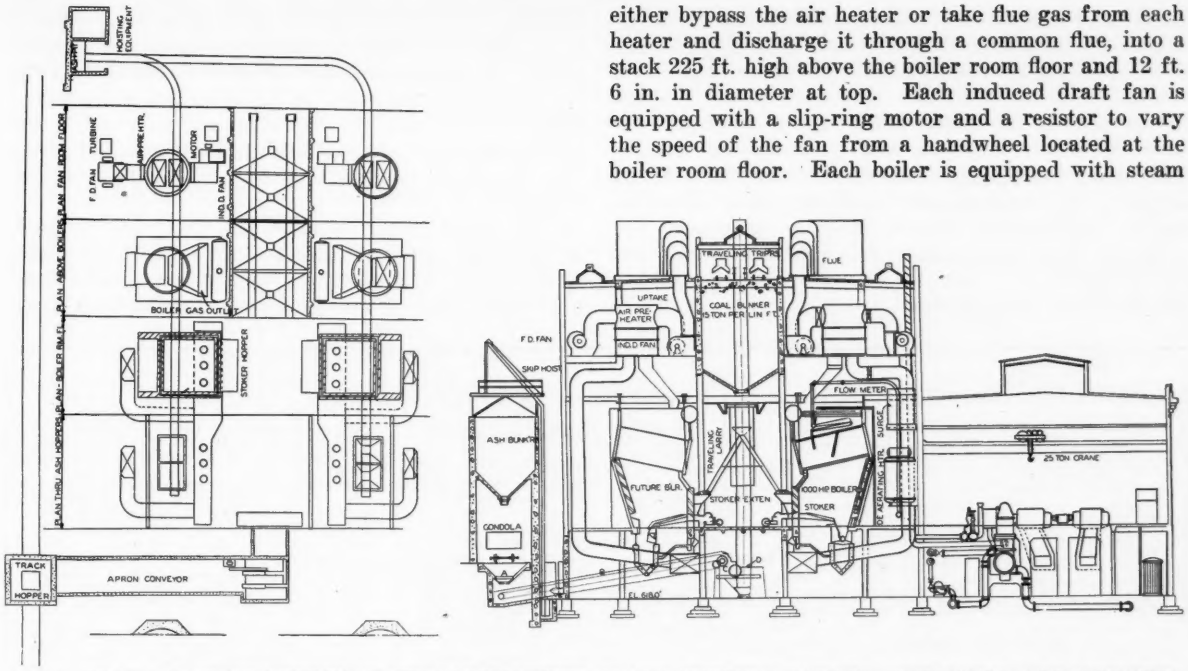


FIG. 3. PLAN AND CROSS SECTION OF THE PARKERSBURG PLANT SHOWING TANDEM GENERATOR ARRANGEMENT

Air Heater Can Be Bypassed

Each boiler is equipped with a regenerative type air preheater to increase 70 deg. F. air from the forced draft fan to 350 deg. F. when the boiler is generating 90,000 lb. of steam per hour. The boilers operate almost 20 hr. a day, six days a week, with an average boiler efficiency of 80 to 82 per cent and a minimum cost for maintenance and repairs. The flue gases leaving the boiler can bypass the air preheater and go direct into the induced draft fan. This is desirable in case the air preheater is out of service for repairs or for week-end summer loads.

Each 1000-hp. boiler is equipped with a forced and induced draft fan of 52,000 c.f.m. capacity using 70 deg. F. air. Each fan is driven by a turbine through a reduction gear. These fans have about 50 per cent over capacity and in case one fan is down for repairs, two of these fans, by operating at full rating, can supply three boilers with sufficient air. When each fan is operating its own boiler, the sectionalizing dampers in the main forced draft duct are closed, and the speed of the fans is on automatic control, actuated by the pressure in the steam main.

Induced draft fans are connected so that they can flow meters, CO_2 recording meters, flue gas temperature and preheated air temperature indicating and recording instruments.

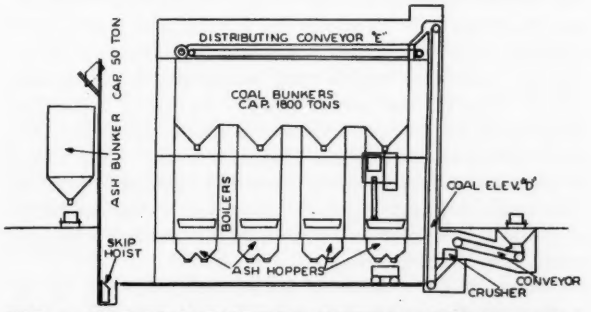


FIG. 4. THE COAL HANDLING SYSTEM IS DESIGNED FOR A CAPACITY OF 100 T. PER HR.

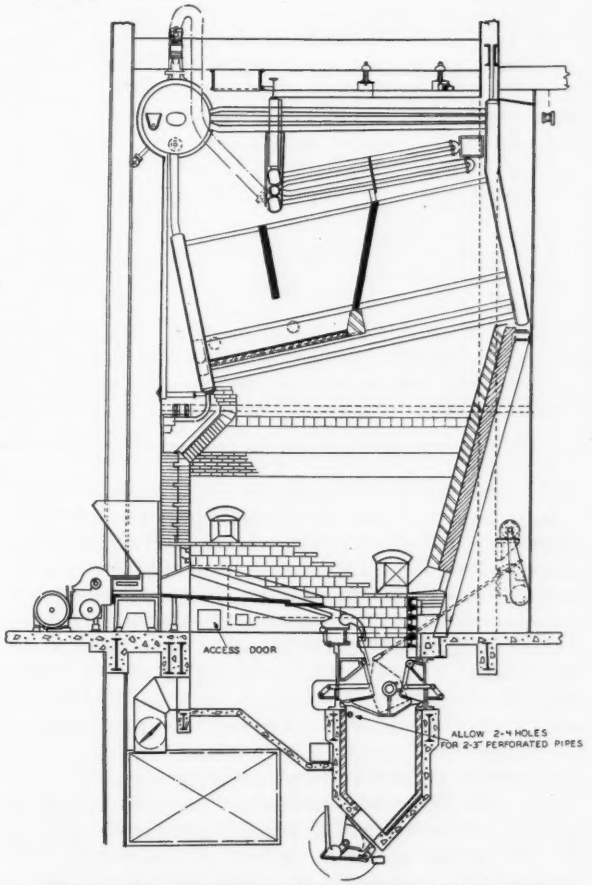


FIG. 5. AIR COOLED BRICK IS USED ALONG THE CLINKER LINE

In the boiler house the feedwater installation is equipped with a large tank having a capacity of 60,000 lb. of water and a deaerating type feedwater heater having a capacity of 300,000 lb. of water per hr. About 70 per cent of the steam to the mill is returned to a surge tank as condensate, and the remaining 30 per cent, which is makeup, is supplied through a Permutit softener, into the same surge tank, by a float operating valve. In case the softener plant is shut down for repairs or backwash, another float valve set 24 in. below the Permutit float, will be put into operation taking the city water for makeup.

blowing 5 lb. steam into the atmosphere. In addition to this, there is a 15-lb. extraction line in the power house. In case there is not sufficient steam to raise the temperature of the water to 220 deg. F. a pressure reducing valve comes into operation and feeds the auxiliary exhaust line and maintains not less than 4 lb. pressure, or almost constant temperature, at the feedwater heater.

The power house is equipped with two 4000-kw. tandem units, each consisting of a 60-cycle and a 100-cycle generator, as shown in Figs. 3 and 6, as well as a 1500-kw., back pressure, 60-cycle turbo-generator set.

Principal Equipment in the Parkersburg Power House of the Viscose Co.

GENERAL

Location.....Parkersburg, W. Va.
Character of service....60 and 100 cycle electric power and steam for process
Electrical capacity, present.....9500 kw.
Electrical capacity, ultimate...13,500 kw.
Boiler capacity, present.....Four 1000-b.hp. units
Total steam delivery, present.....360,000 lb. per hr.
Boiler capacity, ultimate.....Eight 1000-b.hp. units
Total steam, ultimate..720,000 lb. per hr.

BOILER ROOM

4 Edge Moor Iron Co., 10,000-sq. ft., 3-pass, cross drum boilers, designed for 275 lb. gage, 150 deg. superheat with a Foster 3460-sq. ft. interdeck superheater and a Detrick front suspended arch. The heating surface is made up of 406 4-in. I.D. tubes, 20 ft. long.
4 Riley Stoker Corp. underfeed stokers. Projected grate area, each 206.56 sq. ft.
4 Air Preheater Corp., 15,300-sq. ft. air preheaters. The heating chamber is 3 ft. 4⅛ in. high and 11 ft. 1⅞ in. diameter.
4 B. F. Sturtevant Co. No. 100 Turbovane, Design 5, forced draft fans with a capacity of 52,000 c.f.m. at 8.65 in. of water. Driven by Moore 100-hp. type U. R. 3 Design 4 turbines.
4 Buffalo Forge Co., No. 11½ single width, single inlet induced draft fans, with a capacity of 80,000 c.f.m. against 3½ in. static pressure at 560 r.p.m., handling flue gases at a temperature of 366 deg. F. Horsepower requirements 78.3. Driven by a General Electric, 100-hp., 440-v., 3-phase, 60-cycle variable speed slip ring motor.
3 Moore Steam Turbine Co. form S-4 centrifugal boiler feed pumps. One motor driven unit with a capacity of 600 g.p.m. against a discharge head of 682 ft., driven by a 150-hp., 440-v., 3-phase, 60-cycle, 1800-r.p.m. motor; one steam driven 600-g.p.m. unit and one 350-g.p.m. unit, each driven by a Moore steam turbine, operating against 5 lb. back pressure.
1 Rust Engineering Co. 12 ft. 6 in. dia. radial brick stack, 225 ft. above the boiler room floor.
1 Cochrane Corp. deaerating heater, with a capacity of 306,000 lb. of steam per hour, designed to heat 150 deg. water to 215 deg.
Safety valves.....Consolidated Ashcroft Hancock Co., Inc.
Steam gages.....Consolidated Ashcroft Hancock Co., Inc.
Gage glasses and cocks.Yarnall-Waring Co.
Blowoff valves.....Yarnall-Waring Co.
Soot blowers.Diamond Power Specialty Co.
Combustion control system..A. W. Cash Co.
Feedwater regulators (Copes).....Northern Equipment Co.
Desuperheaters....Schutte & Koerting Co.
Holly drip system.....R. B. Hobson

TURBINE ROOM

2 General Electric Co., 4000 kw., Type R, 3600 r.p.m., 12-stage turbines, designed for auto extraction and condensing. Each turbine drives two generators, a 60-cycle Type ABT, 2500-kw. at 0.8 P.F., 3-phase, 2300-v. generator and a 100-cycle, Type ABT, 1500 kw. at 0.65 P.F., 3-phase, 2300-v. generator. Guaranteed performance at 250 lb. gage pressure, 150 deg. superheat, 3 in. abs. back pressure is:

Load-Kw.	Water Rate
4000	13.25
3000	13.75
2000	14.80

2 C. H. Wheeler Mfg. Co., 2-pass surface condensers with a surface of 7000 sq. ft., made up of ¾-in., O.D. No. 18-B.W.G. Admiralty tubes, 16 ft. 2 in. long and connected to the turbine by a copper expansion joint.
2 C. H. Wheeler Mfg. Co. circulating pumps, each driven by a 150-hp. General Electric, 440-v., 3-phase, 60-cycle, 900-r.p.m. motor.
2 C. H. Wheeler Mfg. Co. 85,000 lb. per hr., 50 ft. head condensate pumps. Driven by 7.5-hp., 1800 r.p.m., 3-phase, 60-cycle, 440-v. General Electric motors.
2 C. H. Wheeler Mfg. Co. Radojets with inter and after condenser. Total capacity 58 lb. of free air per hour, using 400 lb. per hr. of 125 lb. gage pressure steam.
4 General Electric Co. generator air coolers of the single pass type, made up of five-foot lengths of ⅝-in. tubes, designed to cool 125 deg. air to 95 deg. F. when using 80 deg. inlet water. The coolers under the 1500 kw. generator require 60 g.p.m. and have a friction head of 10 ft. The coolers under the 2500-kw. generator require 90 g.p.m. and have a friction loss of 15 ft.
3 General Electric Co. exciters; 2 50-kw., 125-v., d.c. generators driven by 75-hp., 3-phase, 60-cycle, 440-v., 1200-r.p.m. motors and 1, 50-kw., 125-v. generator driven by a 3000-r.p.m. noncondensing turbine designed to operate under 250 lb. pressure and 150 deg. superheat.
1 Niles Crane Co. 25-t. crane with a span of 70 ft. 2 in.
2 Atwood & Morrill Co. atmospheric relief valves and 2 reverse flow valves

MISCELLANEOUS EQUIPMENT

2 Worthington Pump & Machinery Corp., 1000 g.p.m. steam driven fire pumps.
2 Worthington Pump & Machinery Corp. 2-in., vertical, single-suction, single-stage, 50-g.p.m. sump pumps driven at 1200 r.p.m. by 440-v., 3-phase, 60-cycle induction motors.
Valves.....Chapman Valve Co. Jenkins Bros. Pratt & Cady Co.
Pipe.....B. F. Shaw Co.
Fittings.....Reading Steel Casting Co.
Spiral riveted pipe.....American Spiral Pipe Works
2 C. H. Wheeler Mfg. Co. 3000-g.p.m., 120-ft. head, booster pumps. These pumps take their suction at 25-ft. head and discharge at 120-ft. Each driven by a 100-hp., 1800-r.p.m., 3-phase, 60-cycle, 440-v. General Electric motor.
Oil coolers.....General Electric Co.
Filters.....S. F. Bowser & Co.
Expansion joints..E. B. Badger & Sons Co.
Flow meters.....Bailey Meter Co.

All the water to the feedwater heater passes through a deaerating condenser as circulating water and then either goes into the feedwater heater, or bypasses the heater and goes directly into the suction of boiler feed pumps. The discharge end of boiler feed pumps is equipped with a "Y" connection, through which water is discharged either into the main or auxiliary boiler feed headers. Each boiler is equipped with a Copes regulator on one side of the drum and a hand-operating valve on the other end of the drum. Ordinarily boilers are operated on one end only by Copes regulators with the hand control as a standby for emergency use.

Two of the boiler feed pumps are operated by a turbine and the remaining two are operated by motors. In case of an excessive amount of steam from the auxiliaries, it is possible to replace one of the steam-driven auxiliaries by a motor-driven one to prevent

These units are selected so that either the tandem drive unit or back pressure unit can be operated to meet the steam and electrical load, or two tandem drive units can be run simultaneously to meet the power requirements of the mill. These units can be operated in the summer time completely or partly condensing when electric loads are higher and steam requirements are lower. During the winter season, especially when the weather is very cold, condensers under each unit are being used as a hot-water heater for the mill, which helps a great deal to bring down the maximum peak of the steam demand curve. Condenser water discharge is connected either to a spray pond, or through a booster pump direct to the mill.

Power house auxiliaries are all motor driven, except a pilot lighting set and a steam-driven exciter set. All of the motor-driven auxiliaries are on the 440-v. circuit.

For the continuous operation of the auxiliaries in the power house, there is installed a 440-v. permanent tie line from the substation No. 1 to the power house, with a reverse current relay, in case the power house auxiliary is cut off. There are 60-cycle and 100-cycle generators, one motor-driven exciter set to each generator and, in addition, there is a turbine-driven exciter set with a capacity equal to the sum of the capacities of both exciters, which can be connected to either one of the exciter buses by switching. The turbine-driven exciter set is used for starting up the plant and for emergency purposes.

The switchboard is a General Electric truck type panel, totally enclosed. Both the generator and feeder panels are connected to double buses (main and auxiliary). Each substation is fed by two feeders from the power house, at ordinary operating conditions; both lines are in service simultaneously, each line being capable of carrying the load in case one is down. All

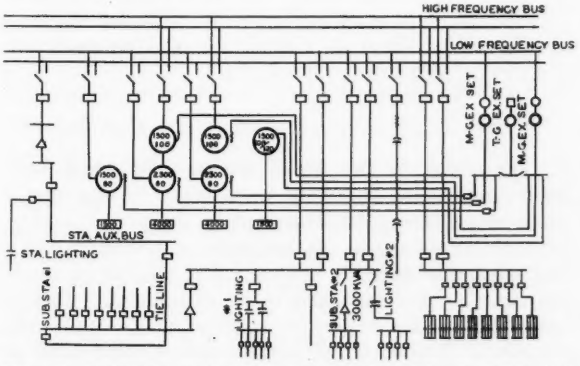


FIG. 6. WIRING DIAGRAM OF BOTH THE 60 AND 100-CYCLE CIRCUITS

feeder lines are under ground except one feeder to the river pump house, which is quite some distance. This line is equipped at each end with lightning arresters and choke coils for the protection of machinery at either side of the transmission line.

Solenoid Valve Controls Emergency Lighting Set

In the transformer substations, all incoming 2300-v. lines are handled by truck type panels for the protection of the operators, but the low-tension 440-v. side of the transformer distribution panels are all open type. Motors throughout the plant are either 440 v. or 2300 v. Several of these large motors are synchronous type and when operating they are used for power factor corrections, so that the average power factor in the plant is kept between 80 and 82 per cent. Most of the 2300-v. motors are equipped with oil immersed switches and push-button control for the safety of the operators.

For the lighting system, the load is as nearly as possible divided into three equal parts, and each part is connected to each phase so that the generator in the power house will carry a balanced load. In the power house there is a turbine-driven pilot lighting set. The valve on the steam end of this turbine is kept shut by a solenoid from the lighting circuit. As long as the lighting circuit is in service, this solenoid, being energized from the same source, will keep the steam line closed. As the lighting circuit fails, this valve will open immediately and put the pilot lights in service in the entire mill.

Leakage Through Shut-Down Hydraulic Turbines*

By C. M. Allen

AMOUNT OF LEAKAGE through wheel gates when a hydraulic turbine is shut down varies considerably, depending on original design, age (with its attendant wear), foreign matter caught in the passages,

TABLE SHOWING LEAKAGE THROUGH SHUT-DOWN UNITS WITH HEAD GATES OPEN

No.	Rated H.P.	Head (Ft.)	Discharge Full Gate (c.f.s.)	Leakage-Wheel Gates Shut (c.f.s.)	Leakage in Per Cent of Discharge at Full Gate	Unit Old or New
1	6,200	205	321	19	6.0	New
2	5,500	97	692	44	6.4	Old
3	725	39	243	9	3.7	Old
4	1,600	39	404	24	5.9	Old
5	1,520	39	458	67	14.6	Old
Average					7.6	Old

No. 4, as usually shut by operator, had leakage of 36 c.f.s. or 8.8%

neglect in closing tight, and so on. Unless some form of tight shut-off gate is used above the wheel for any considerable period of shut-down, more attention should be paid to this type of loss. Recently a plant has been tested because it had a low overall efficiency. The plant consisted of five generator units and five grinder units. About half of the wheels were shut down during the winter months. The tests showed that, whereas the wheels when operating normally were of good efficiency, when shut down they leaked so badly that the plant as a whole was throwing away about 1000 good horsepower. Details of several leakage tests are shown in the accompanying table.

*From report of Hydraulic Power Committee, N. E. L. A.

Expansion must be provided for in all steam lines. For comparatively low pressures, expansion joints are used but for high pressure work in modern plants it is customary to take care of the increased length by means of large bends. The amount of expansion depends upon three factors—the material of which the pipe is made, the length of the pipe and the difference in temperature between the pipe hot and cold.

For wrought iron pipe, the coefficient of expansion per degree Fahrenheit is 0.0000068. The total expansion of a pipe line in feet is, therefore, the product of the length in feet, the coefficient of expansion and the temperature difference in degrees Fahrenheit. Coefficients for steel and bronze are about 0.0000067 and 0.0000111 respectively.

In service, the pipe will not expand the theoretical amount because the outside is not as hot as the steam which the pipe carries. As the efficiency of the pipe covering increases, the expansion increases and for well covered pipe is almost equal to the theoretical amount. It is customary to cut pipe short by about half the expected expansion, so as to reduce the stresses when the pipe is hot.

Are Your Pulp and Paper Mill Steam and Power Problems Wisely Handled?

by

John F. Rhoades, *Chief Engineer*
The Mead Pulp and Paper Co.
Chillicothe, Ohio

WHAT ARE THE PROBLEMS and uses for steam in mills of the pulp and paper industry? The question is so broad in its application that it would take many pages of tiresome reading or concentration to explain its many uses in the various phases of pulp and paper manufacture; however, it is only intended in a concise way to state what value and part it may play in any phase of the industry.

Importance of Plant Location

Location of plants and product produced have an important bearing on whether water power or steam is to be the factor for producing power for the plant operation. Consistent with the investment necessary and returns with a comfortable margin, it has sometimes been questioned whether or not the large amount of investment for a water power development can actually compete with a steam plant. In the one case, the burden of a water power development may be large; in the other case, the raw product coal may be a continual high carrying charge. In the first case, the development usually has a long term of life which, in time, results in comfortable returns; in other words, a long pull investment.

Uses for Steam

Steam, however, must be available in all cases for process application unless it is purely a ground wood-pulp producing plant, or similar. In some cases, the small amount needed is produced from wood refuse.

In water power developments of a more recent construction a balance is obtained by converting surplus water power into electric energy, which in turn is converted into steam by means of the electric boiler. When surplus water power is not available the coal boilers or other fuel boilers are brought into use. The question naturally arises, "Why both kinds of steam boilers?" Rainfall and river flow unfortunately are not constant and a plant has to be constructed to fit conditions at some particular location so unless large natural water storage basins or lakes are a part of the water power system, an even flow of water for producing power will only be available during flood stages. Large basins or lakes are usually created to retain water which can be controlled and used over the dry season and this further increases the large investment necessary for producing power in this manner.

It is, however, about the only way in which the large amount of power required can be obtained in the isolated forest areas where the transportation and cost of coal is a costly item.

Production of ground wood pulp and paper is the usual product of this class of paper mill. By the sulphite process, however, steam must be produced to cook wood chips. If paper is also produced at the same plant, steam for drying the paper must be supplied, usually at 20 lb. This pressure is high for engines producing power and exhausting against this back pressure so bleeder turbines can be used for driving the machines or better still, extraction type turbines installed for producing power and steam extracted for low-pressure process work. In some cases, double extraction turbines are installed, furnishing process steam around 90 to 100 lb. or higher, for cooking and 20 lb. for drying and heating purposes.

Steam Balance and Power Plant Equipment

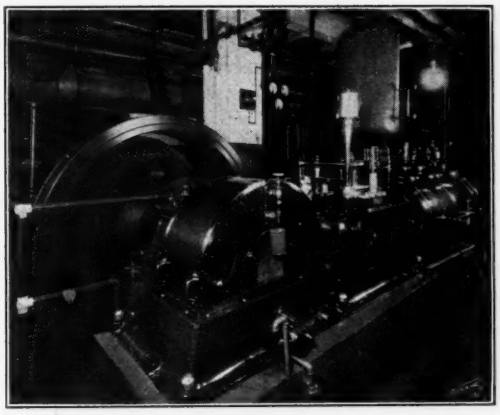
The steam balance which can be maintained is the governing factor in plant operation. In the case of extraction type turbines located in the power plant, a problem arises in the transmission of process steam to the paper machines for drying and of electric power for driving the machines and other equipment. This arrangement is the better for large plants, as individual engine or turbine drives require more skilled labor for operation and so increase costs. With extraction type turbines, the process steam extracted is clean and trouble from oil in condensate to boilers or the dryers of paper machines is eliminated. As the amounts of steam extracted are used only as needed, there is none wasted to atmosphere. Condensate is returned to the boiler plant and the heat balance is made complete by furnishing extracted steam to the feedwater heater to maintain the feedwater at 210 deg. and so help to maintain steady operation of the boilers.

Economy

Either in old or new plants today, the importance of properly equipping a plant with steam and power producing units of such a nature that continuity of operation is assured cannot be discounted. This item forms a large part of the costs. Small waste of power and steam usually is an item not readily noticed by the ordinary plant but shut-downs must be eliminated as they are one of the main items that determine whether the plant shows a loss or pays dividend.

BOTH THE FINENESS and the volatile content influence the ignition point of coal. Thus a certain coal with 35 per cent volatile has an ignition temperature of about 1300 deg. F. when pulverized to a diameter of 0.002 in. but this increases to about 1900 deg. at a diameter of 0.005 in. Another coal with 5 per cent volatile pulverized to 0.002 in diameter had an ignition point of 1600 deg. F., or about 300 deg. higher than the first coal.

Records Show Savings Made By Heat Balancing



INSTALLATION OF UNAFLOW STEAM ENGINE AND USE OF ALL EXHAUST STEAM FOR HEATING WHILE PURCHASING EXTRA POWER, REDUCE POWER COSTS. BY LAWRENCE B. BROWN*

PURCHASE OF PART of the entire load, where the amount of exhaust steam that could be used for heating purposes was limited, proved to be the most economical method of supplying power, light and heat for the Jonathan Club of Los Angeles, California, as will be seen by inspection of the set of records, illustrated in this article.

SAVINGS ARE ACCOMPLISHED BY ADJUSTMENT OF LOAD

Savings in power costs that can be accomplished by proper adjustment of load and purchase of a portion of the necessary electricity, are not generally appreciated by managers of clubs, hotels, and similar organizations.

Williams 11 to 7 Alt. 4/4/29
300 kw. generated.
LBS.-STEAM= 21,080 = 2635 lb. per hr.
GAS= {27,122 cu. ft. / 1,598 lb. = 212 gal.
EVAP.= {778 lb. water per 1000 cu. ft. gas fired / 13.2 lb. water per lb. fuel oil
B.H.P.= 82
EFF.= 74%
COST= $8.218 per 1000 lb. steam (fuel cost only)
PRESS= 150 lb.
CO2= 8%

FIG. 1. DAILY INDIVIDUAL FIREMAN'S RECORD ACTS AS INCENTIVE TO THE SEVERAL FIREMEN TO BEAT ONE ANOTHER'S RECORD AS WELL AS THEIR OWN

Proper recording and analysis of costs, such as those presented in this article, readily shows the advantage to be gained by the establishment of an adequate record system in connection with such a plant.

Originally, all the steam generated at the Jonathan Club was used in the heating system and for various water heaters. This steam was generated at 150 lb. pres. and passed through reducing valves at pressures of from 2 to 3 lb. to the heating system, of 8 lb. to the hot water and swimming pool heaters, of 35 lb. to the kitchen, 100 lb. to the laundry, 20 lb. to the Turkish bath and 60 lb. to the valet shop.

Two thermostatically controlled regulating valves were installed in the two 4-in. steam lines running to the hot-water heaters. These were set to control the temperature between 160 to 180 deg. Each heater was supplied with a trap through which the condensate passed. Due to the large quantities of hot water frequently drawn from the heaters during the period between 8 a. m. and 9 p. m. these control valves would open wide almost simultaneously due to the rapid drop in temperature caused by the sudden demand for hot water.

During the heating season we generally cut in the system at 4:30 a. m. and cut it out at 12:00 midnight. At 4:30 to 5:30 a. m. an average steam flow of 2400 lb. was required to fill up the entire heating system of 40,000 sq. ft. Since the burners on the boilers were shut off from midnight until 4:00 a. m., giving the boiler sufficient time to cool off considerably, the sudden demand for steam threw a considerable load on a cold boiler.

All the condensate returns from the hot-water heaters, heating system, kitchen and laundry were passed to a closed hotwell which was vented by a 4-in.

ENGINEER'S DAILY COMPARATIVE REPORT

	COMPARISON DATES	
	4/4/29	4/4/28
Total steaming hours	112¼	88½
Total heating system hours	24 E	6
Pounds of steam generated in 24 hours	96,720	50,820
Pounds of fuel oil burned in 24 hours	121,458	75,445
Cost of 24 hours' operation	$39.40	$34.10
Average hourly boiler horsepower	126	64
Evaporation, pounds of water per 1 pound fuel oil	796 - 135#	673 - 114#
Boiler efficiency	75.2%	64.4%
Steam pressure, pounds	150	128
Cost fuel oil per barrel	$0.17	$0.21
Cost to make 1,000 pounds steam	Alt. $.041 Fuel $.214	Alt. $.068 Fuel $.031
Average steam per hours, pounds	4030#	2118#
Total kilowatts, 24 hours	Steam 1490 Power 2070	2925
Cost per kilowatt	$0.0116	$0.015
Total cubic feet water consumed 24 hours	1106	880
Total cubic feet gas consumed 24 hours	15,500	12,500
Pounds of ice issued	3,000	3,100
	Thursday	Wednesday
OUTSIDE TEMPERATURES		
HIGH	56°	70°
LOW	54°	52°

E = Exhaust steam
Ramon Mary

FIG. 2. DAILY POWER PLANT COST RECORD AND COMPARATIVE REPORT

*Chief engineer, Jonathan Club power plant, Los Angeles, Calif.

vent line. The makeup feedwater, which had been reduced to zero hardness by water softeners, was taken at an average temperature of 46 deg. from the 4-in. supply line and passed to hot-water heaters. The exhaust steam from the feed pumps was connected to the heating system during the cold weather and exhausted to the atmosphere during the warm weather.

With the above type of load, our boiler output would vary from 25 to 180 hp. in five minutes, during the period between 7:00 a. m. to 9:00 p. m. The average

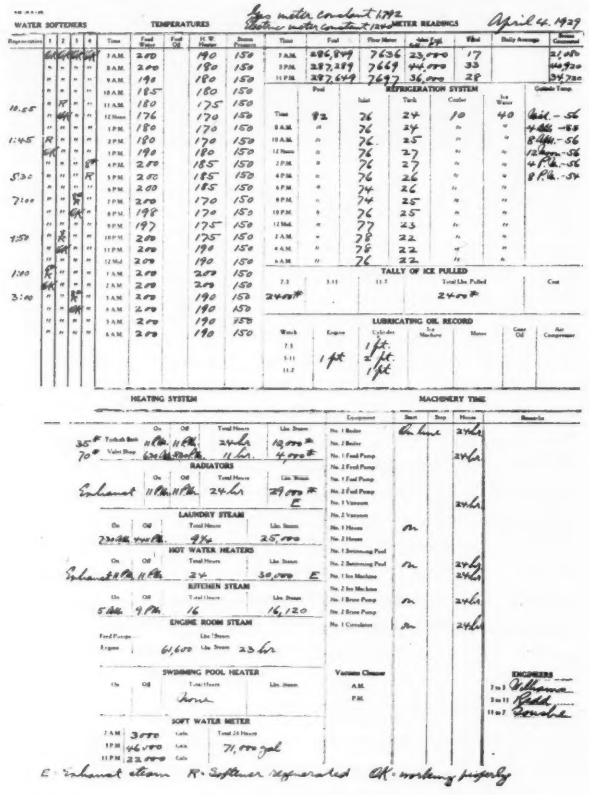


FIG. 3. DAILY COMPLETE LOG RECORDS HOURLY READINGS

feedwater temperature for 24 hr. was about 145 and the average b.hp. for the 20 hr. was about 68.

Engine Exhaust Now Used for Heating

Purchase of a 156-hp. Skinner Unaflow steam engine direct connected to a 125-kv-a. Westinghouse alternator was decided upon. This unit was installed in the boiler room where a space 20 by 32 ft. was available. Since the boiler room is located in the basement, as is usual in plants of this kind and no large doors were accessible for the passage of large machinery, a 10 by 8-ft. hole was broken through the brick walls from the sidewalk elevator shaft to the boiler room. The total weight of all of the new equipment was 15 t., the heaviest single piece, which was the cylinder and frame of the engine, being 5 t.

Preparation of the foundation and installation of the entire engine and piping were made by the regular engineering force of the club, the heavier pieces being set in place with the help of a rigger's crew. For three days the engine was run at a very low speed and then for each succeeding day the speed was increased slightly until the 10th day, when the engine was run at full speed and the load was thrown on the generator. In this way the bearings were "run in" in an excellent way. The electric wiring was done by a local electrical contractor while the engine was being installed and this work was completed by the time the other work of installation was completed.

Boilers Now Operating Continuously

Since the installation, boiler service was put on a 24-hr. basis. The engine is shut down only once a week for cleaning, inspection and adjustment, if any is needed. Indicator cards are taken just before shutting down the engine and comparisons are made with previously made cards. The engine exhaust is used for heating purposes. Instead of cutting off the heating system on every pos-

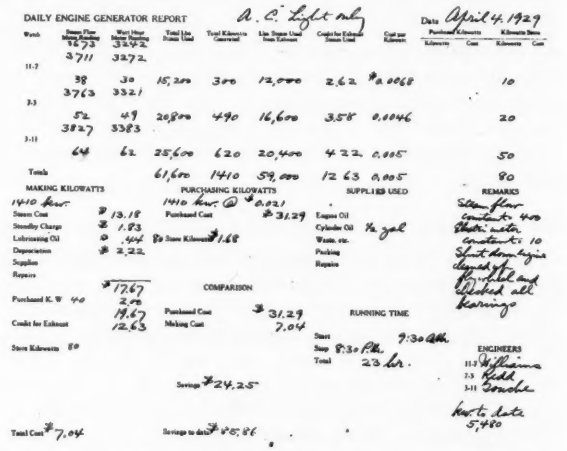


FIG. 4. DAILY ENGINE-GENERATOR SHOWING COSTS AND OPERATING DATA FOR ALTERNATING-CURRENT LIGHT

sible occasion, we now keep the mains full of steam at all times. The average steam flow of our heating system is 1100 lb. per hour.

Continuous flow of steam from the exhaust headers now passes through the heating elements for 24-hr., the pressure regulating valves on the hot-water heaters having been taken out. The temperature of the hot-water heaters now ranges from 175 to 190 deg. When the temperature reaches 190 deg., the steam valves are choked down to maintain a 190-deg. temperature during the period of small demand for hot water. The swimming pool heater is piped to the exhaust steam line on the atmospheric side of the back pressure valve and at night, when very little exhaust is passing through the heating system and hot-water heaters, the exhaust steam that would ordinarily be wasted is passed through the swimming pool heater. In this way very little steam is wasted and a temperature of from 79 to 81 deg. is maintained at all times.

Hot-Water Heaters Carry Heavy Load

There are two Whitlock Pipe & Coil Company 1100-gal. hot-water heaters on the laundry service line and feedwater is now drawn from these heaters. The temperature range of these heaters is from 190 deg., during operation of the laundry, to 200 deg., after the laundry has been shut down at 4:30 p. m. for the day. Our makeup feedwater now enters the hotwell tank at about

195 deg. and gives an average feedwater temperature of 200 deg. as against last year's corresponding operation at 145 deg. On an average, 12,000 gal. of soft water and of 6000 gal. of raw water for rinsing purposes are used in the laundry.

Between the hours of 11:00 p. m. and 7:00 a. m., our lighting load averages only about 30 kw-hr. The changes made did not increase the operating personnel. The only additional charges that should be applied due to the purchase of the engine are fuel, depreciation, supplies, lubricating oil and standby charge. Using the exhaust from the engine to maintain the hot-water temperatures and provide heat for the heating system, we can now generate lighting current cheaper than it can be bought.

Tests on the engine at different loads and with a back pressure of 5 lb., gave the following results:

Load in Kw.	Steam consumption in lb. per kw-hr.
105	36.8
75	34.4
60	36.0
30	39.2

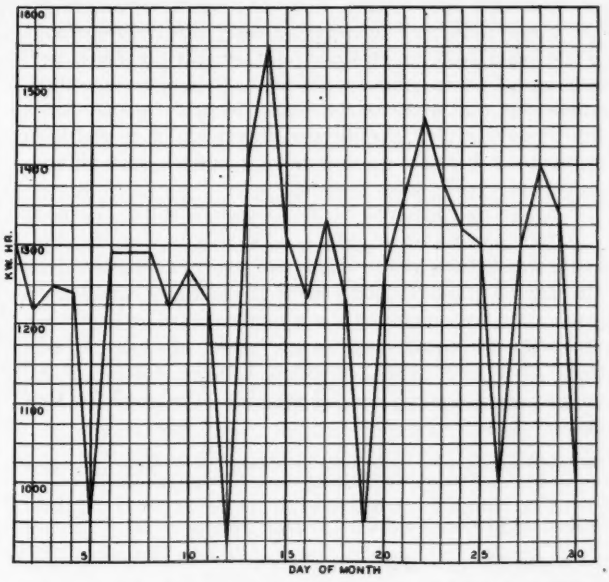


FIG. 5. CHART SHOWING VARIATION IN KILOWATTS USED FOR LIGHT DURING THE MONTH OF MAY, 1929

Change in Boiler Baffling Raises Efficiency

Changes made in our boilers included a change in the baffling. The tubes in the boiler are arranged with 4-in. space between the bottom row and the next upper row. Above this the rows are staggered and lie 2 in. apart. Firebrick blocks had been placed on the upper part of the bottom row so as to expose about one-third of the tube to the radiant heat and furnace gases, thus forming a lower baffle.

We changed the location of this baffle, in order to increase the radiant heating surface, placing the baffle blocks on top of the row of tubes just above the bottom row. The new type of baffle had to be both thin and strong, because of the small space available, so we added a rib to the center of the block to give it strength. We experimented with wooden patterns on the dead boiler until a satisfactory block was made. This change increased our boiler efficiency 2½ per cent.

TABLE I. COMPARATIVE DAILY COSTS FOR MONTHS OF APRIL, 1929, AND APRIL, 1928

Apr.	Costs 1928 Fuel	Costs 1928 Light	Costs 1928 Total	Costs 1929 Fuel	Costs 1929 Charges	Costs 1929 Total	Kilowatt Hours 1928	Kilowatt Hours 1929	Increased Load K.W. 1929	Temperatures 1928	Temperatures 1929	Daily Saving	Savings to Date
S1	$11.92	$14.70	$26.62	$18.32	$4.05	$22.37	700	1270	570--$11.97	63° 55°	75° 55°	$4.25	For'd.$307.17
2	18.01	25.41	43.42	20.35	4.49	24.84	1210	1330	120-- 2.53	60° 54°	66° 52°	14.58	321.75
3	18.84	25.41	44.25	20.25	4.50	24.75	1210	1390	180-- 3.78	61° 54°	63° 56°	19.50	341.25
4	15.63	22.36	37.99	20.65	6.49	27.14	1065	1440	375-- 7.87	70° 52°	56° 54°	10.85	352.10
5	15.63	22.78	38.41	20.91	6.05	26.96	1085	1390	305-- 6.41	70° 51°	55° 51°	11.45	363.55
6	12.43	24.47	36.90	19.71	4.49	24.20	1165	1380	115-- 2.43	66° 54°	55° 47°	12.70	376.25
7 S	11.27	24.05	35.32	15.38	4.05	19.43	1145	1020	125 less 2.63	68° 52°	62° 45°	15.89	392.14
S8	11.27	12.08	23.35	19.06	4.49	23.55	575	1280	705-- 14.81	72° 54°	62° 48°	Less .20	391.94
9	14.01	23.10	37.11	19.51	4.05	23.56	1100	1320	220-- 4.62	73° 60°	63° 50°	13.55	405.49
10	14.97	23.10	38.07	18.98	4.49	23.47	1100	1290	190-- 3.99	68° 55°	62° 48°	14.60	420.09
11	14.30	22.79	37.05	18.32	4.05	22.37	1085	1240	155-- 3.26	70° 56°	65° 51°	15.82	435.91
12	14.37	24.05	38.42	19.26	4.49	23.75	1145	1280	135-- 2.84	72° 58°	61° 53°	14.67	450.58
13	15.07	24.78	39.85	18.49	4.05	22.54	1180	1220	40-- .84	74° 62°	63° 52°	17.31	467.89
14 S	13.10	23.70	36.80	14.80	4.49	19.29	1100	960	140 less 2.94	74° 63°	63° 59°	17.51	485.40
S15	10.32	14.07	24.39	18.10	4.05	22.15	670	1300	630-- 13.23	78° 56°	78° 56°	2.24	487.64
16	13.99	23.42	37.41	19.38	4.49	23.77	1115	1400	285-- 5.99	65° 54°	70° 57°	13.64	501.28
17	16.91	24.78	41.69	19.75	4.05	23.80	1180	1430	250-- 5.25	65° 56°	58° 55°	17.89	519.17
18	13.78	23.10	36.86	17.64	9.49	27.13	1100	1330	230-- 4.83	67° 54°	60° 56°	9.73	538.90
19	13.87	24.78	38.65	18.69	4.49	23.18	1180	1340	160-- 3.36	70° 55°	62° 54°	15.49	544.39
20	16.38	24.78	41.16	18.14	4.05	22.19	1180	1290	110-- 2.31	70° 55°	63° 55°	18.97	563.36
21 S	13.15	21.42	34.57	14.17	4.05	18.22	1020	960	60 less 1.26	69° 55°	62° 57°	16.35	579.71
S22	8.36	15.44	24.80	17.98	4.49	22.47	735	1280	545-- 11.45	74° 58°	61° 57°	2.33	582.04
23	15.57	22.68	38.25	18.05	4.49	22.54	1080	1310	230-- 4.83	70° 53°	65° 52°	14.71	596.75
24	14.06	24.78	38.84	18.08	4.05	22.08	1180	1330	140-- 2.94	65° 57°	63° 52°	16.76	613.51
25	14.43	23.73	38.15	18.30	8.17	26.47	1130	1390	260-- 5.46	68° 55°	60° 55°	11.68	625.19
26	12.93	20.37	33.30	18.13	4.49	22.61	970	1460	490-- 10.29	76° 58°	58° 55°	10.69	635.88
27	13.93	23.42	37.34	17.66	4.49	22.15	1115	1380	185-- 3.47	75° 58°	62° 57°	15.19	651.07
28 S	13.31	24.15	37.46	14.85	4.05	18.90	1150	1000	150 Less 3.21	78° 59°	62° 56°	18.56	669.63
S29	9.81	15.02	24.83	18.13	4.05	22.17	715	1280	565-- 11.86	78° 59°	65° 54°	2.66	672.29
30	13.26	21.42	34.68	20.35	4.49	24.84	1080	1330	310-- 4.41	78° 60°	68° 58°	9.84	682.13

Formerly our steam flow fluctuated considerably. At times hot-water heaters, laundry and house would draw heavily on the steam supply, so that the steam flow amounted to as much as 3800 lb. per hour, at which times our two 4-in. valves would be wide open. Since the installation of the engine, the steam flow has been evened off, because we now have a much better balance of steam supply and demand.

Watch performance cards, as we call them, are made out for each watch engineer, as shown in Fig. 1. This card shows each watch engineer just what he has done during his watch. The records of the three cards taken each day are combined on a similar card, which then gives the average for the 24 hr. A set of daily records, Fig. 2, is also kept, on which I make entries of all engine room records and all supplies purchased for that day.

TABLE II. COSTS FOR THE MONTHS OF APRIL, 1929 AND APRIL, 1928

Total lb. live steam, 1,690,000 at $0.213 per M.....$359.97
Total exhaust used, 1,284,800 at $0.213 per M..... 273.66

Final cost of steam to engine.....$ 86.31

Live steam cost	$359.97	Total operating cost, engine	$503.57
Standby charge	55.00	Used, 1,284,800 steam exhaust	Credit 273.66
Depreciation	66.66	Final total	$229.91
Lubricating oil	7.04	If purchased, 38,410 kw.	$806.61
Supplies	3.50	Cost as made	229.91
Purchased kw.	11.40	Saving	$576.70
Total operating cost	$503.57		

Cost to make per kw..$0.0051

$576.70 savings for April, 1929

Savings $576.70
Store charges 72.75

Grand total savings.$649.45

$649.45 ÷ 30 days equals $21.64 per day average saving.

Comparing this with April of a year ago we have:

April, 1928, fuel cost per M cu. ft.	$0.21	April, 1929, fuel cost per M cu. ft.	$0.17
Total fuel, 1,999,988 cu. ft.	$ 420.00	Total fuel, 3,242,276 cu. ft.	$551.19
Total a.c. light, 31,406 kw.	659.51	All charges—oil, dep., standby	143.60
Total cost	$1079.51	38,410 kw. total cost	$694.79
1928 total cost	$1079.51	1929 kw. used	38,410 kw.
1929 total cost	694.79	1928 kw. used	31,405 kw.
Savings	$ 384.72		7,005 kw. more in 1929
7000 kw. × 0.021	$ 157.11		
Savings	384.72		
Total savings	$ 531.83	for mo. of April	$17.72 daily average
	72.75	stores	
	$ 605.58		

Figuring same fuel rate for 1928—1,999,988 cu. ft., $339.99

0.21	$420.00	$531.83
0.17	399.99	20.01
	$ 20.01	$511.82 savings

$511.82 savings
72.75 stores $17.06 per day average

$584.57 total

Complete hourly readings are kept on a daily complete log, Fig. 3. On the back of this sheet I record the following items for quick comparison: kw., steam, gas, evaporation, boiler hp., efficiency, cost, pressure and CO_2 reading. A daily engine-generator report, Fig. 4, showing costs and operating data, is also kept.

Operating Conditions Represented Graphically

Graphical charts such as that shown in Fig. 5 are also kept for the following for each month: kilowatts supplied to stores daily, daily average hourly load in br.hp., daily alternating-current power consumption, daily direct-current power consumption, daily gas consumption for boilers, daily water consumption, daily kitchen gas consumption and daily ice consumption.

In order to be able to see at a glance what machines are in operation in the plant, I have established a "machinery operation board," which is located in the boiler room where all watch and repair engineers can see it and make proper changes when necessary. This board is 3 by 3 ft. On it are grouped the various types of machines and boilers such as pumps, fans, ice machines and boilers under each of which are the words: running, stopped and repairs. Under each of these words are ¼-in. holes into which red taper plugs are inserted according to the condition of service. It is the duty of the watch engineer to change these plugs whenever he starts or stops a piece of equipment. With this board we have an instant check on what is going on in the plant.

Cost Records Indicate Large Savings

Comparative costs for the month of April, 1929, compared with similar costs of the same period for the preceding year and showing the savings accomplished are shown in Table I. Complete costs and charges are given in Table II for the month of April, 1929, during which the power consumed amounted to 38,410 kw. hr., which, if purchased at the prevailing rate, $0.021, would have cost $806.61.

Our savings are due principally to generating just as much power by means of our engine-generator set as will enable us to use all of the exhaust steam for our various heating processes and then buying the rest of our electrical energy. In this way we really use the engine as a reducing valve and as a by-product have the energy it produces.

Mixtures of coal and air in conduits must be thoroughly mixed before the stream is subdivided to supply different burners. Where space permits, the installation of a cone or venturi section in the direction of flow is an effective method.

When the mixture is passed through the converging section, the air is accelerated more rapidly than the coal, causing a certain turbulence. The diverging section following the cone reduces the loss in head caused by the obstruction.

Velocity is also an important factor, for if it is so low that the coal separates out, fuel will be delivered in slugs, causing uneven firing and losses in combustion. The actual velocity to be used depends upon the fineness of the coal and shape of the duct. It should not be less than 30 ft. per sec. and is commonly higher.

Condenser Tube Deterioration Affected by Design

FROM THE PROGRESS REPORT NO. 2, OF THE A.S.M.E. SPECIAL RESEARCH COMMITTEE ON CONDENSER TUBES

IT HAS BEEN SUGGESTED that factors other than bad water, tube material and manufacture might be the cause of rapid condenser tube deterioration and belief has been expressed that in addition to bad water, entrained air and turbulent water, conditions within the water boxes and tubes affect the kind and degree of condenser tube deterioration, so that where condenser tube failure is caused by corrosion, erosion, impingement attack or pitting, turbulence and entrained air aggravate the condition or may even be the cause of it.

In considering corrosion, there is, perhaps, no doubt that certain elements contained in the circulating water produce this form of failure but the rapidity of deterioration therefrom may be greatly increased by the presence of air. This condition becomes worse if the inner surface of the tube becomes less smooth and further retards the free flow of air bubbles. Erosion must be considered because corrosion generally accompanies it with the same destructive action, except that the corroded part of the tube is carried away by the action of the abrasive substances in the circulating water.

Impingement attack and pitting are similar but the former appears only in the inlet ends of the tubes while the latter may occur at any point in the tube. Where corrosive elements are contained in the circulating water or where an electrochemical action takes place, the rate of deterioration is greatly increased and the pits will be jagged and rough, whereas in those cases where there is no corrosive or electrochemical action the pits will appear as smooth, round holes.

In order to bring the matter to a common basis, the general type of condenser tube failures were designated and defined as follows:

NINE TYPES OF TUBE FAILURE DEFINED

1. General thinning or general corrosion. The wasting away or thinning down of the tube. The inside surface of the tubes is evenly corroded without the formation of pits or dezincified spots. Little or no basic salt on the tube.
2. General Dezincification. The tube is generally not thinned down to any considerable extent. The zinc is taken out, leaving a mass of spongy and more or less brittle copper behind. This shows, when broken, a red or brick-like fracture extending from the inside partly or completely through the tube wall. It is frequently more or less irregular, so that the tube wall is completely dezincified in places and on other places not entirely so.
3. Deposit Attack or Pitting. Small, round pits or pinholes beneath green salt and cuprite. Foreign deposits often accompany this type of corrosion. When these pits or pinholes contain plugs of copper, this is known as "plug type" dezincification.
4. Tailed-Type Pitting. Pits formed by the removal of the scale and having a deep section at the upstream side and a shallow tail at the downstream side.
5. True Erosion. The tube is worn away by the action of solids in the circulating water, often accompanied by corrosion.
6. Impingement Attack. Corrosion caused by air bubbles and generally confined to the inlet end of tube. This may be uniform thinning or it may appear as grooving.
7. Scale Thinning. Scale kept thin by chemical action, resulting in corrosion and in isolated pits.
8. Solution. Scale absence due to the presence of acids, etc., resulting in general thinning.
9. Splitting and Season Cracking. Splitting in a longitudinal plane caused by internal strain in the tube metal or undetected defects within the tube walls. Season cracking may be due to the same cause as splitting, and in addition may be due to stresses set up in expanding and rolling the tube ends in the tube sheets.

It was expected that data on water box design, piping arrangement, pump design and pump speed would give a reliable indication of the condition of the water entering the condenser tubes. It was contended that installations in which the water was least agitated would contain the least amount of entrained air, have less turbulence and cause fewer condenser tube failures. Because of the limited number of replies to the questionnaire it is extremely difficult to make accurate comparisons but a study of the data seems to indicate that there may be factors other than bad water and tube material which tend to this rapid deterioration.

DATA SHOW NOTHING DEFINITE ON EFFECT OF AGITATION

Design comparisons of the data as a whole neither bear out nor refute the above contention. A number of companies report their greatest failures where design conditions apparently cause the least agitation, while about an equal number report that the reverse is true. Such comparison, however, does not take into account factors other than design and is, therefore, misleading.

It is apparent from the data that the installations where the design of the circulating water piping causes the water flow to have a greater angular change in passing from the pump discharge to the direction of flow through the tubes have the greatest number of tube failures. This is in line with the sub-committee's belief regarding turbulence and entrained air.

A number of companies report tube failures at the inlet end of the first pass due to pitting impingement attack and erosion and it is probable that these failures are caused by the turbulent condition of the circulating water as it enters the tubes. The projection of ferrules and wearing tips into the water box has also been increased, with the object of reducing this effect.

As to tube material, admiralty mixture is used practically exclusively in plants where salt water is employed for circulating purposes and many of the fresh water installations also employ this metal.

Tube failures, computed as the percentage of condenser surface failures per 1000 service hours, show considerable variation, running from 1.035 to 3.147 per cent for salt water and from 0.198 to 1.347 per cent for fresh water.

Moving a 35,000-Kw. Unit in 25 Days

DETAILS OF PLANNING BY THE UNION ELECTRIC LIGHT & POWER CO. TO MOVE CAHOKIA UNIT NO. 1 TO VENICE STATION IN RECORD TIME. PART II*

AFTER DETERMINING DEFINITELY that demands for increased capacity at Cahokia Station could be met best by transferring the 35,000-kw. Unit No. 1 to Venice Station and installing a 75,000-kw. unit in the same space, much detailed planning was necessary in order to carry such a formidable undertaking through in the minimum time.

Not only was it necessary to move the turbine and auxiliaries, rebuild boilers and install the new equipment but it was necessary to synchronize these various changes with the manufacturers' schedules, the electric load on the system, the railroads and various company departments.

During the period that the 35,000-kw. machine was out of service, the system capacity of 484,500 kw.

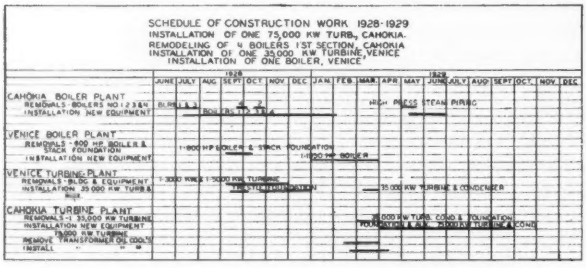

SCHEDULE OF CONSTRUCTION WORK 1928-1929
INSTALLATION OF ONE 75,000 KW TURB., CAHOKIA.
REMODELING OF 4 BOILERS 1ST SECTION, CAHOKIA
INSTALLATION OF ONE 35,000 KW TURBINE, VENICE
INSTALLATION OF ONE BOILER, VENICE
1928
1929
JUNE JULY AUG SEPT OCT NOV DEC JAN FEB MAR APR MAY JUNE JULY AUG SEPT OCT NOV DEC
CAHOKIA BOILER PLANT
REMOVALS - BOILERS NO 1 2 3 & 4
INSTALLATION NEW EQUIPMENT
BOILERS 1 2 3 4
BOILERS TO STAY
HIGH PRESS STEAM PIPING
VENICE BOILER PLANT
REMOVALS - 400 HP. BOILER & STACK FOUNDATION
INSTALLATION NEW EQUIPMENT
1-400 HP BOILER & STACK FOUNDATION
1-1920 HP. BOILER
VENICE TURBINE PLANT
REMOVALS - BLDG. & EQUIPMENT
INSTALLATION 35,000 KW TURB. & BLDG.
1-3000 KW & 1-5000 KW TURBINES
HEAVY EXCAVATION
35,000 KW TURBINE & CONDENSER
CAHOKIA TURBINE PLANT
REMOVAL 1-35,000 KW TURBINE
INSTALLATION NEW EQUIPMENT
75,000 KW TURB. COND. & FOUNDATION
FOUNDATIONS & BLDG. - SWITCH TURBINE & COND.
REMOVE TRANSFORMER OIL COOLS
INSTALL

FIG. 14. GENERAL CONSTRUCTION SCHEDULE SHOWING HOW WORK WAS TO BE CARRIED ON

(Cahokia 195,000 kw., Keokuk 135,000 kw., Ashley 122,000 kw., and Venice 32,500 kw.) would be reduced by 40,000 kw. because the 35,000-kw. unit would be out of service and the 5,000-kw. unit at Venice would have to be taken out in advance in order to pour the new foundation. After the 35,000-kw. machine was running at Venice, the total capacity would again be 479,500 kw. while, after the 75,000 kw. was installed at Cahokia, the total capacity would be increased to 554,500 kw. Peak load occurs in December and high water, which limits the output of Keokuk, normally occurs in May or June so that the change-over was limited by these two periods. The month of March was finally selected.

Having decided upon these points the engineering department under Chief Engineer E. H. Tenney laid out the schedule shown in Fig. 1 showing the changes planned, the approximate time required and the date. These changes included boiler room revisions at both Venice and Cahokia; transferring the 35,000-kw. unit to Venice and installing the 75,000-kw. unit at Cahokia. The construction schedule was drawn up in March, 1928. Actual construction work was to be started in July, 1928, and was to extend through to September, 1929, when the 75,000-kw. unit would be on the line.

Naturally the removal of the 35,000-kw. and the installation of the 75,000-kw. unit overlapped considably and in order to give a more comprehensive view of the entire situation the construction schedule was expanded to show just exactly what equipment was affected by the change. The complete schedule is shown in Fig. 8. (Part I.) Work progressed through the summer and the latter part of November when plans for changing the 35,000-kw. unit were started. As a preliminary, a detailed report showing the status of the work scheduled was prepared. A portion of this report covering the first few items is given in Fig. 15. Contract delivery dates, progress of the layout in the drafting room, and progress of the construction department were included so that all those who were to take part in the program were fully informed of every part of the work.

At this meeting, it was decided that the turbine No. 1 was to be removed from Cahokia beginning Monday morning, March 4, working three shifts until the unit was on the line at Venice six weeks later. Later this schedule was cut two weeks and the work started on March 1. Arrangements for manufacturer's service men or supervisors, railroad facilities, extra or special tools and some general features of the change were gone into. Because of the limited speed of the turbine room crane it was decided to use additional caterpillar cranes to handle the lighter pieces. As finally decided, three extra cranes were used at Cahokia. Their positions are indicated in Fig. 11 by positions A, B and C. (Part I.) An A frame with a 2-t. block was located over the turbine and a locomotive crane was available to be used mostly for loading, shifting and spotting cars. Similar arrangements were made at Venice.

BOILER ROOM REMOVALS	STATUS
1. Brick boiler setting	Completed
2. Chain grate stoker	Completed
3. Induced draft connection	Completed
4. Steam header connection and non-return valve	Completed
5. Feedwater piping at boiler	Completed
6. Boiler and superheater	Completed
7. Ash pit	Completed
8. Floor & building steel	Completed
9. Stack foundation	Completed
10. Main steam header	New steam header being drafted. No removals started on old header.
11. Main feedwater line	1 motor driven and 1 steam driven pump to be removed from Cahokia and installed at Venice. Location at Venice being included in heat balance general layout which is being drafted.
BOILER PLANT INSTALLATION	No removals started on this line.
1. Concrete foundations	Boiler and furnace foundations in progress in drafting room.
2. Structural steel for Bldg. and Boiler	Members designed and layout figured. Detailing of steel will start Nov.23,28.

FIG. 15. SECTION OF PROGRESS REPORT PRESENTED NOV. 22, 1928

During December, representatives of the General Electric and Worthington companies went over their part of the work and offered suggestions; railroad clearances were investigated, tools, slings, shackles and eye bolts ordered and detailed procedure and methods of removing and installing the equipment were drawn up for the removal of the equipment from Cahokia.

The detailed procedure program, in part, was as follows:

1. Equipment to be removed consists of:
   a. Turbine, b. Condenser, c. Generator, d. Exhaust and

*Part I with drawings and photographs of the equipment, flow diagram of the unit and Figs. 1 to 13 appeared in the July 1 issue.

piping, h. Oil, water and steam drains, k. Eductor and condenser, l. Fire extinguisher, CO_2, and water lines, m. Gage and instrument piping, n. Generator air cooler and ducts, p. Condensate pumps, q. Oil cooler, r. Bleeder heater and piping, s. Heat exchanger and piping, t. Two boiler feed pumps 500 g.p.m.

2. Marking drawings where possible shall consist of layouts of Venice proposed installation contemplating re-use of parts from Cahokia Station which parts can be marked accordingly before removal starts. Removed parts will be marked V, C, and S respectively for Venice, Cahokia and scrap.

3. Construction and handling equipment shall consist of:
   a. Turbine room crane
   b. Two tractors with booms
   c. Warehouse trucks—2 ton
   d. Trolley beams, trolleys and chain blocks
   e. Locomotive crane
   f. Railway box cars, flat cars and locomotive
   g. Special tools
      1. Turbine wrenches
      2. Condenser wrenches, tube removal mandrels and packing hooks
      3. Jacks, slings, shackles, and eye bolts
      4. Timbers, blocking and planking
      5. Cradles for rotor and spindle
      6. Tarpaulins
      7. Steel wedges for turbine base
      8. Rollers

4. Personnel

   Shift Crews: There shall be three 8-hr. shifts headed by:
   a. Nine experienced G. E. Co. men to act as lead men on turbine removal.
   b. One experienced Worthington Co. man to act as lead man on condenser removal.

   Personnel

   Crews and departments other than shift crews shall consist of:
   1. G. E. Co. district turbine engineer to keep in touch with job and coöperate with construction department.

      G. E. Co.—Two shipping department men to arrive ahead of removal operations in sufficient time to build necessary cradles, cribs, bins, etc., required for packing of turbine and generator parts.
   2. Worthington Co. man to arrive sufficiently ahead of removal operations to advise on removal methods and replacement parts.

5. Sequence and method of removals and preliminary preparation thereto shall be as follows:
   a. Previous to date of shutting down No. 1 unit. See Fig. 17.)
   12. One box car with suitable bins built in and properly marked as according to marking plans shall be set on west side of turbine room. One flat car shall be set on east side of turbine room. Both by March 2. Locomotive crane shall be thoroughly inspected and be put in first-class working order and be placed in position just east of main turbine room door. Crane shall be placed Sunday, March 3.
   13. Marking chart showing a diagram of bins in box cars shall be made up so that shipping clerk on job can definitely locate parts in the car as well as in the proper car. Charts to be similar to Fig. 16 and printed on stiff strong paper. One copy to be tacked inside the car, one copy to remain on record at Cahokia and one copy to be available at Venice for distribution of parts.
   14. Place shoring under condenser.
   15. Hang chain blocks for lowering condenser doors and cover plates.

6. Methods of removals will be as follows:
   a. An A frame located in position "A," Fig. 11 (Part I), will be used to lift from turbine.
   b. Tractor crane located in position "B," Fig. 11 (Part I), to remove end bells of generator, exciter parts, outboard, bearing cap, generator fire extinguisher box, cable get-a-way box, and outboard pedestal. Also to load foregoing onto warehouse trucks and as time permits to change location of tractor and assist in loading railway cars. Also tractor will reach over gallery and hoist condenser tube boxes, generator air duct, generator air cooler, and such of the pipe fittings and valves that are to be loaded on cars for Venice.
   c. Turbine room crane to be used as is and will assist tractors in lifting any of the small parts that may be ready in the first four hours at which time a definite sequence of heavy lifts is provided throughout the entire removal of the turbine generator and condenser.
   d. Locomotive crane at start of job will be located in position "C," Fig. 11 (Part I). It will, as far as possible, weather and conditions permitting, unload parts from warehouse trucks into or on a car and shall do such short shifting of cars as is not taken care of by the locomotive.
   e. Plant locomotive will make long car shifts taking loaded cars to a point where same will be picked up by railway locomotive and bring in empties and place in position so that locomotive crane can readily handle them.
   f. Immediately open and remove doors of condenser so that crews at each end can enter and start removing ferrules ahead of door openings. With the removal of the ferrules work of removing tubes can start. The tubes immediately in front of doors can be pulled out while the work of removing the quarter sections of water box cover plates is in progress.

      To remove a tube after the ferrules are off from each end the tube will be driven with a suitable mandrel eastward slightly beyond the depth of stuffing box. At this time a packing hook will be inserted in the west end stuffing-box and two fiber washers and corset lace packing removed. The tubes shall then be pushed or driven with a suitable mandrel through the east tube sheet sufficiently so that it can be grasped on the west end and removed; all tubes will be passed by a crew of men directly to an adjacent space on 20 grade.

      As quickly as possible bolts in water box will be removed and box lifted out of way so that access may be readily had to all tubes which are close to the outer ring or ribs of box. Staging shall be available for placing in position for tube removal operations.

      During the tube removal operation, crews of men will be removing all bolts possible in the condenser shell, leaving such bolts as necessary until time of lifting.
   g. The various turbine removal crews will conduct the work of removing all bolts, studs and parts in a method familiar to all. It will be necessary, however, to prepare immediately for unseating the generator and exhaust bed plates from the grout or concrete foundation. To do this slots will be cut into the concrete foundation approx. every four feet for the insertion of long taper drive wedges, to break the grout loose from the older concrete of the foundation where a seam is located. To avoid low-pressure piping, e. Oil piping other than that on turbine proper, f. Condensate piping, g. Bleeder steam

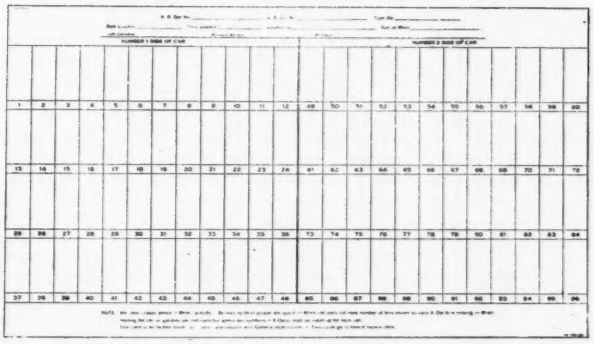


FIG. 16. CHARTS SIMILAR TO THIS WERE MADE TO SHOW LOCATION OF PARTS IN ALL CARS

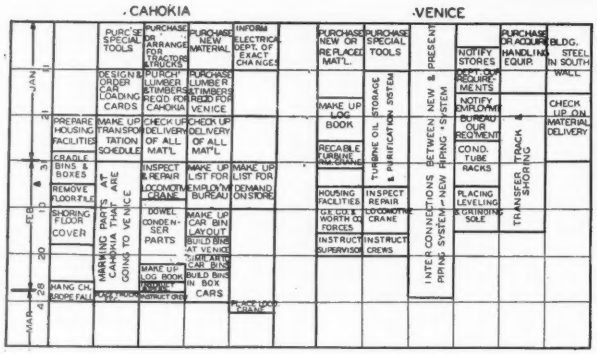

CAHOKIA
VENICE
PURCHASE SPECIAL TOOLS
PURCHASE OR ARRANGE FOR TRACTOR STRUCKS
PURCHASE NEW MATERIAL
INFORM ELECTRICAL DEPT. OF EXACT CHANGES
PURCHASE NEW OR REPLACED MATL.
PURCHASE SPECIAL TOOLS
NOTIFY STORES DEPT. OF REQUIREMENTS
PURCHASE OR ACQUIRE HANDLING EQUIP.
BLDG. STEEL IN SOUTH WALL
DESIGN & ORDER CAR LOADING CARDS
PURCH. LUMBER & TIMBERS REQD FOR CAHOKIA
PURCHASE LUMBER & TIMBERS REQD FOR VENICE
MAKE UP LOG BOOK
NOTIFY EMPLOYMENT BUREAU OF YOUR REQUIREMENTS
CHECK UP ON MATERIAL DELIVERY
PREPARE HOUSING FACILITIES
MAKE UP TRANSPORTATION SCHEDULE
CHECK UP DELIVERY OF ALL MATL.
CHECK UP DELIVERY OF ALL MATL.
RECABLE TURBINE ROOM CRANE
COND. TUBE RACKS
CRADLE BINS & BOXES
INSPECT & REPAIR
MAKE UP LIST FOR DEMAND ON STORES
MAKE UP LIST FOR DEMAND ON STORES
HOUSING FACILITIES
INSPECT & REPAIR LOCOMOTIVE CRANE
PLACING LEVELING & GRINDING SOLE
REMOVE FLOOR TILE
LOCOMOTIVE CRANE
EMPLOYMENT BUREAU
SHORING FLOOR COVER
DOWEL CONDENSER PARTS
MAKE UP CAR BIN LAYOUT BUILD BINS AT VENICE
G.E. CO. & WORTH CO. FORCES
INSTRUCT CREWS
INSTRUCT SUPERVISOR
MARKING PARTS & CRANE GOING TO VENICE
MAKE UP CAR BINS BUILD BINS IN BOX CARS
HANG CH. ROPE FALL
PLACE LAST CRANE
JAN. 21 28
FEB. 3 10 20 28
MAR. 4
NEW & PRESENT PIPING SYSTEM
BETWEEN NEW & PRESENT PIPING SYSTEM
INTER CONNECTIONS
TURBINE OIL STORAGE & PURIFICATION SYSTEM
TRACK & TRANSFER SHORING

FIG. 17. THESE CHARTS WERE MADE UP TO SHOW THE PRELIMINARY WORK NECESSARY FOR THE REMOVAL AND INSTALLATION

the additional friction which is set up at the anchor bolt locations from grout filling between the anchor bolt and bolt hole, it is advisable to expose each anchor bolt below the castings so that same can be burned off with a torch.

8. Experimental removal of 25 condenser tubes.

The time requirements for removal of the 10,800 condenser tubes has a direct bearing on the following items: 1, Method of shell removal; 2, Starting time of shell removal; 3, Starting time of reinstallation; 4, Method of reinstallation; 5, Number of tube replacements; 6, Quantity and type of special tools.

It is therefore advisable to remove 25 tubes as soon as possible under load conditions and obtain accurate time record of each step in the operation of removal and also the time required for reinstallation of these tubes for use in estimating the time schedule for condenser installation at Venice.

From experience and records available it appears that 45 hr. will be required to remove all of the tubes. This figure is based on 12 men working on each end of the condenser removing ferrules and tubes and allows an average of 3 min. per tube. Unless results of experimental removal materially reduce the average time per tube, it means that the condenser shell can be removed with the turbine room crane and also that the condenser must be erected independently and without interference to the turbine at Venice as part of the turbine will already be in position at such time as condenser shell arrives at Venice.

9. New or Replaced Material consists of the following:
   1. Turbine; a, Shrink studs for turbine wheel case; b, Gaskets.
   2. Condenser; a, Tubes—Quantity depends on experimental tube removal. Actually about 300 were needed); b, Bolts; c, Ferrules; d, Red Lead; e, 8-oz. canvas gaskets; f, Beams for condenser removal; g, Trolleys for condenser removal.

A portion of similar detailed directions for the installations of the equipment at Venice are as follows:

1. Equipment to be installed (in addition to that removed from Cahokia)
   a. Oil storage tanks and purification facilities
   b. Automatic float controls and alarm systems for surge tanks
   c. Feedwater pressure, regulator and governor from Cahokia
   d. Makeup pumps
2. Personnel
   Shift Crews. There shall be three 8-hour shifts and each crew shall consist of: (Substantially the same as at Cahokia)
   Personnel (substantially same as at Cahokia)
3. New or Replaced Material: 1. Condenser exhaust piece. 2. Phillips expansion joint. 3. Hot well casting. 4. Air ejector. 5. Upper two quarters of discharge end of condenser. 6. Make-up piece at circulating water discharge connection. 7. Condenser bolts. 8. Special 1⅛-in. dowel pins for condenser sections. 9. Condenser gaskets. Gaskets made to fit bolts by peaning on castings. 10. Bolts subjected to steam. 11. 300 lb. red lead ground in oil. 12. 10 gal. boiled linseed oil. 13. 4—4-in. paint brushes. 14. 12 Sail needles for sewing gaskets. 15. Sail twine. 16. 2 Palms for sewing. 17. Corset lace packing—30 in. long Parafine impregnated. Order from Worthington Co. 18. 300 ferrules for condenser tubes. Order from Worthington. 19. New pipe fittings, and valves for all systems. 20. Air cooler ducts. 21. Exhaust connection and valve. 22. CO_2 tanks for fire extinguisher. 23. Hydraulic gate valves. 24. Car load of turbine oil—2300 gal.
4. Preliminary preparation will be as follows: (See Fig. 17.)
5. Methods of Installation will be as follows:
   1. The railway car with stator shall be placed at turbine room door. The car shall then be thoroughly blocked from trestle to platform. Sufficient blocking shall then be placed on trestle extension on east to provide sufficient area for movement operations of the stator. The stator skid or cradle will then be jacked up and rolls inserted under same. The transfer cars shall also be located on transfer track at proper location and properly blocked against tipping. The stator will then be moved in a turning direction, toward the building so its axis will pass through an arc of 90 deg. onto the location of the transfer cars where it will be lowered to platforms of same and be moved through the building opposite its location on generator bed frame. The cradle or skid for stator will be so designed that the removal of the lower members of the skid which are used to roll in a westerly direction can be removed and leave a framework of members or skids that will be headed in a northernly direction toward foundation. Rolls will be inserted between these members and a heavy skidway at a proper elevation to roll stator over its location on the generator bed frame. Then it will be slowly lowered by raising one end at a time with the turbine room crane and continually decrease the amount of blocking and skids until it finally rests on generator bed frame. Further study will be given the necessity of installing a heavy timber framework inside the foundation of sufficient strength to use for jacking and lowering purposes in the removal of the timbers and skids under the stator.
   2. The field will be handled similarly to the stator into the building. It will be skidded and rolled off of the transfer cars onto position D, Fig. 12 (Part I), where a skidway will be provided to enter end of field into end of stator.
      The field will then be carefully eased through the stator until a cradle can be inserted under inboard end where the weight of this end will be picked up and the field, then suspended, will be carried inward to its proper distance, and the pedestal then inserted and field lowered into its bearings.
   3. All other parts are within the capacity of the turbine room crane and will be lifted and lowered in the sequence as shown on sequence chart.
   4. Condenser tube installation shall be as follows: Wooden bulkheads shall be provided at the outside of the north tube sheet. This bulkhead to be built in quarter sections, which are to be designed to be removed independently of each other.
      The tubes will be entered from the south end and will be passed inward from the storage adjacent to the building by a line of men.
      2000 tubes will be inserted every 8 hours. As soon as 2700 or ¼ of the total tubes are inserted, crews will start packing at the south end. As soon as tubes are packed at south end in one quarter to allow for working space another crew will start installing ferrules. When the ferrules are installed on the south end quarter, the north end bulkhead or tube stop will be removed and packing operations

L.C.Bell - Venice

1. Arrange for electrical changes at Venice
2. Supply man to cut out lines
3. Transfer trucks
4. 30 by 16 ft. bent East of trestle
5. Arrange for illumination
6. Watchmen
7. Employee transportation
8. Turbine oil
9. Re-cable turbine room crane
10. Inspect and repair locomotive crane.

E.Luxemberg - Cahokia

1. Obtain turbine wrenches
2. Obtain condenser wrenches
3. Arrange for electrical changes
4. Supply man to cut out lines
5. Furnish crane operators
6. Furnish locomotive crews
7. Remove and protect instruments
8. Bus service
9. Shrink studs
10. Sheathing and tar paper
11. Nails
12. Studs
13. Arrange for Cahokia illumination

FIG. 18. EACH MAN WAS ASSIGNED DEFINITE JOBS IN ORDER TO AVOID DUPLICATION

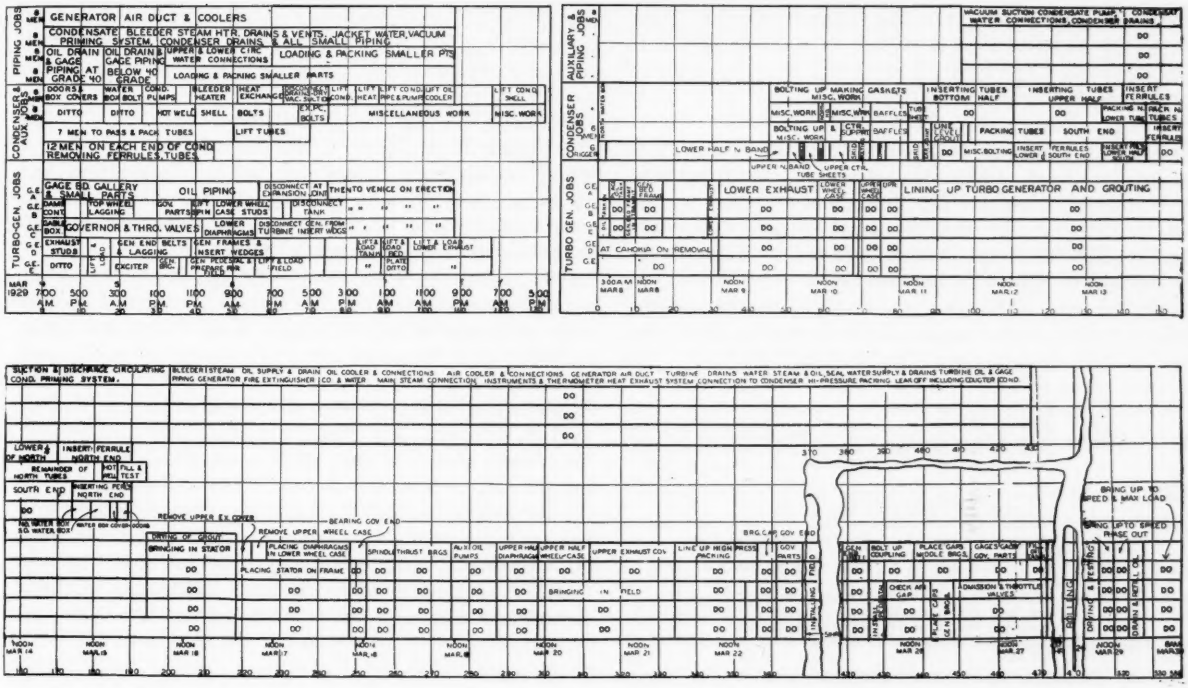


FIG. 19. WORK DURING EACH HOUR OF THE ENTIRE MONTH WAS PLANNED TO AVOID DELAY

at the north will be started following with the ferrules and the other three quarters will be continuous operations in the sequence heretofore described.

5. The assembly of the condenser shell will be as follows: The north water box will have previously been lowered at north end of foundation. The lower half of the north band will be brought in and lowered on timber skidway at proper elevation. The upper half of north band will be lowered onto lower half and the connecting joint made. The quarter sections of north tube sheet will now be in progress of installation while the ring in its entirety is moved northward the distance required for lowering lower half of center band. The top two side pieces of center band with its braces will be lowered onto lower half and joints made. This center ring will then be connected to north band and then both bands moved northward to allow for lowering of south lower band onto skids. Then the upper south band will be lowered onto lower half of band and joints bolted up. The south band will then be pushed up to center band and joint made up. During period of assembling bands, the baffles and support sheets will be in progress of installation. After south band is made up to center band then the entire unit will be pushed north and in its proper north and south position, at which time the expansion joint will be placed and fastened. The south tube sheet will also be placed during movement of shell northward. At this time scaffolds which have already been prepared, will be placed slid into position at each end of condenser for insertion of tubes.
6. Testing and Preliminary Operation.
As soon as condenser tubes are completely installed and hot well connected the condenser will be tested for leakage. During period of filling and testing, the water boxes and heads will be placed in position and bolted up.
The turbine will be rolled as soon as possible after being completely assembled. The turbine tests will be similar to tests applied to new turbines.

In order to avoid duplication of details in the above procedure and methods, definite responsibilities were assigned to individuals, two typical examples being shown in Fig. 18. Preliminary work necessary to carry out the turbine change were shown on charts as in Fig. 17 while the actual change was scheduled by hours for the entire month of March, that is, from the time the turbine was shut down at Cahokia until it was on the line at Venice. Charts for the two stations are shown complete in Fig. 19.

Work in each case was divided into three general classifications: turbine and generator; condenser and auxiliary and piping jobs. Where necessary these jobs were further subdivided, as shown in Fig. 20, the piping jobs necessary in connection with the removal of the turbine and auxiliaries from Cahokia. Further details of the duties and responsibilities of each of the key men are shown on the organization chart, Fig. 13 (Part I).

In order to facilitate transportation and arrange to have cars and motive power on hand when needed, the transportation schedule, a portion of which is shown in Fig. 21, was made. From this a shorter schedule, showing only the number of cars, the hour and date of leaving Cahokia, was made for the purpose of arrang-

Job No.	Description
1	Cut out and blank off all lines required to isolate No.1 unit from station systems.
2	Remove turbine oil, drain and gage piping.
3	Disconnect main steam line elbow at the throttle valve and blow off Sargol joint at other flange of elbow.
4	Remove high pressure packing leak-off piping, valves and eductor condenser
5	Remove fire extinguisher lines.
6	Remove expansion joint from circulating water discharge line. Remove expansion joint from circulating water suction line.
7	Remove atmospheric relief valve and pipe.
8	Burn off 10 in. drain from east water box of condenser. Burn off above drain connecting into this line.
9	Disconnect suction and discharge of hot well pumps.
10	Remove piping of air cooler
11	Disconnect piping of oil cooler
12	Remove cold water lines from heat exchanger.
13	Disconnect bleeder steam piping to No. 1 heater.
14	Remove vacuum pump suction line between condenser and 1st valve from pump.
15	Disconnect bleeder heater drains and seals.

FIG. 20. SCHEDULE OF PIPING JOBS IN CONNECTION WITH REMOVAL OF THE EQUIPMENT FROM CAHOKIA

ing for locomotives and transportation to Venice. Altogether 27 carloads were moved in 6 trains as shown in Fig. 22.

All departments worked three shifts: 7:00 a. m. to 3:00 p. m.; 3:00 p. m. to 11:00 p. m. and 11:00 p. m. to 7:00 a. m. Temporary men worked 7½ hours with ½ hr. for lunch, while the lead men, manufacturers' representatives, regular pipefitters and crewmen worked 8¼ hr. without any definite lunch period and stayed the first 15 min. of the next shift in order to familiarize the oncoming shift with developments.

At the peak, 305 men were employed at Cahokia and 359 at Venice. The majority of these men were temporary employes engaged for this particular job. An

Mar.7	9:30 AM	Place flat car 40 in. high in turbine room to receive stator.
Mar.7	6:00 PM	Remove car with stator and arrange for special move to Venice. This car to have transportation man ride with it direct to Venice. Trip to take not over three hours.
Mar.7	6:30 PM	Place flat car in turbine room to receive turbine oil tank and generator bed plate.
Mar.8	7:00 AM	Remove flat car with oil tank and generator bed frame and proceed to Venice as special move. Transportation man to ride with the train.
Mar.8	7:30 AM	Place flat car in turbine room to receive 1/2 of lower exhaust piece.
Mar.8	7:00 PM	Remove flat car with 1/2 of lower exhaust piece and box car and proceed to Venice as special move. Transportation clerk to ride this train.
Mar.8	7:30 PM	Place box car west of turbine room to receive small parts.

FIG. 21. SECTION OF THE TRANSPORTATION SCHEDULE

advertisement was placed in Sunday's paper, Feb. 24, directing applicants to report at Cahokia the next day at 9:00 a. m. They were met by several interviewers who accepted or rejected them. The accepted applicants were given slips showing their classification rate of payment and were taken to the turbine room to fill in the regular employment questionnaire and for the doctor's physical examination. After the examination the new employe was given a tag, a number, told when

Train No.	No. of Cars	Left Cahokia	Arrived at Venice Station
1	5	1:35 P.M. March 4th	5:00 P.M. March 4th
2	8 and locomotive crane	1:45 A.M. March 5th	5:35 P.M. March 5th
3	3	11:05 A.M. March 6th	3:00 P.M. March 6th
4	4	1:20 P.M. March 7th	4:15 P.M. March 7th
5	3	1:40 P.M. March 9th	3:55 P.M. March 9th
6	4	2:50 P.M. March 9th	5:15 P.M. March 9th

FIG. 22. ALTOGETHER 27 CARLOADS WERE MOVED

to report and where to catch the bus. About 10 per cent more men than actually needed were hired.

Actual work started on Feb. 1 when tile around unit No. 1 was removed and the floor covered with heavy planking. Preceding the shutdown after the peak Friday morning, March 1, some preliminary work was carried on; the condenser shell was thoroughly dowelled to facilitate erection and some concrete work for the new 75,000-kw. unit poured.

At Venice, the new 1950-hp. boiler had been installed, pressure raised from 180 to 325 lb. on two of the older boilers and a new foundation built for the 35,000-kw. machine which was to be rechristened Venice Unit No. 2. On this foundation, sole plates had been set and leveled so that erection started at Venice upon the arrival of parts. The turbine was first rolled at 3:10 p. m. Monday, March 25, and was on the line under full load at 6:01 p. m. March 27 after 25 working days. No work was done March 1 while the turbine was cooling, nor Sunday, March 3, while the foremen and supervisors were discussing the proposed schedule after the first day's work.

During the working period, Unit No. 2 at Cahokia was bulkheaded off by a plank partition in order to avoid interference. Some of the old foundation had to be removed in order to place the foundation for the new machine and this steel and concrete was cut out as fast as the equipment was removed.

Some concern was felt at first regarding the condition of the condenser tubes after six years of service and the possibility of large losses from handling. Actually less than 300 out of the total of more than 10,000 needed to be replaced. Tubes were in good condition, clean with no traces of scale or corrosion, outside surface comparatively free from oxide and dirt, so that they were simply wiped with a cloth after being removed and reinstated without further cleaning.

Working three shifts required excellent lighting and this was accomplished largely by means of floodlights. At Cahokia, 10 floodlights were placed around the condenser and turbine with the yard lighted by the roof lights. At Venice a string of lights on each floor was

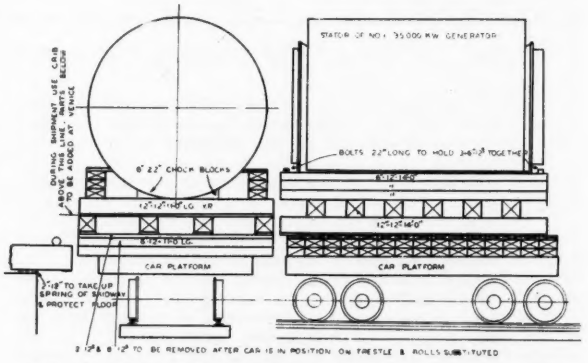


FIG. 23. DETAILS OF CRIBBING FOR SHIPPING THE GENERATOR STATOR

provided around the foundation with the yard lighted by 10 floodlights in addition to the permanent roof lights.

The heaviest piece to handle, the generator stator, (123,000 lb. and 10 ft. in diameter) was loaded by the crane at Cahokia, but had to be taken in to Venice on rollers because it was beyond the weight of the 35-t. turbine room crane. For shipment the cribbing consisted of 6, 12 by 12 in. 11-ft. long timbers placed crosswise of the car and resting on 1¼ by 12 in. oak boards. Three 6 by 12-in. timbers 14 ft. long and bolted together were placed longitudinal of the car on each side to support the feet of the stator which was blocked firmly by 8 by 22 in. chock blocks. The assembly is shown in Fig. 23. At Venice the stator and cribbing was jacked up and 12 to 12 in. stringers 14 ft. long resting on 1¼-in. oak boards were added above sufficient blocking of lighter timbers to bring the stringers up to the level of the rollers as shown in Fig. 23. The entire assembly was then swung around 90 deg. onto the skid timbers and rolled into position.

Unit No. 1 was the first of the five Cahokia machines to go into operation. It started serving St. Louis on Oct. 17, 1923 and from that date to Feb. 1, 1929 generated 637,158,200 kw-hr.

Reducing Power Costs with Diesel Engines

RELIABILITY, HIGH EFFICIENCIES OF SMALL SIZES AND QUICKNESS AND COMPARATIVELY LOW COST OF COMPLETE PLANT ERECTION ARE FACTORS IN THE CHOICE OF DIESEL ENGINES FOR MOTIVE POWER. BY R. C. DEMARY*

ATTEMPTS to secure lower power rates have caused private power plant owners and municipalities to investigate operating costs and determine what reduction, if any, would be effected by the adoption of Diesel engine power. The result of these investigations has been to establish the Diesel engine as a prime mover in many small and medium sized plants and also as a standby unit for some large steam-electric and hydro-electric plants.

Fuel and labor costs form approximately 85 per cent of the generating cost in the average steam plant and therefore any important saving must come from those two items. The cost of labor or the cost of fuel per ton in steam plants shows no sign of decreasing. In the small and medium sized plant the cost of producing power is enormously high due, in most instances, to lack of refinement. High steam pressure, superheat and many other refinements are not justifiable expenses in many such cases.

DIESEL EFFICIENCY HIGH EVEN IN SMALL SIZES

We must look elsewhere, therefore, to obtain the saving desired and find that the use of the Diesel engine gives efficiency nearly constant at 32 to 35 per cent over the whole range of sizes as well as of load conditions. The Diesel, therefore, permits the division of the load between two or more smaller units without materially affecting the efficiency. A 1000-kw. plant may consist of two 500-kw. units or one 500-kw. unit and two 250-kw. units or it may be made up in any other combination desired. One or two of the units may remain idle without resulting in standby losses but such units are always ready to pick up full load in from one to two minutes, if necessary. Additional units may be economically installed at any time.

Not only has the stationary field been quick to see the advantages of the Diesels but railroads and marine interests have followed. After a thorough investigation, the Erie R.R. adopted Diesel-electric locomotives for switching service in the yards at Akron, Ohio, and after a year's use found the cost of operation to be less than one-third that of the steam locomotives which they replaced. So satisfactory has been their operation that another 100-t. unit has just been ordered.

The Diesel engine is clean and quiet in operation. The exhaust, because of complete combustion, is practically colorless, odorless and without soot.

DIESELS SERVE MUNICIPAL PLANTS FOR WATER, LIGHT AND POWER

Municipalities may combine the waterworks with electric light and power and by operating with Diesels the extra operating costs for pumping are very small. Pumps may be of either reciprocating or centrifugal type, direct or motor driven with low cost current from Diesel engine generators. These units, regardless of how they are driven, have great flexibility and meet every need. Additional pumps may be cut in when a peak load comes on and will deliver their full capacity almost immediately. By piping two units for either parallel or series operation, the latter may be used, if desired, to furnish high pressure.

Recently the Colby, Kansas "Free Press" published the following item: "The question as to the best way to dispose of the increasing surplus from the operation of the light and water plant was settled by Council yesterday when they adopted a resolution to waive all further tax levies upon all property within the city limits." The Colby plant has been in operation for the past 8 yr. and at no time has any charge been made for city lighting or hydrant rental.

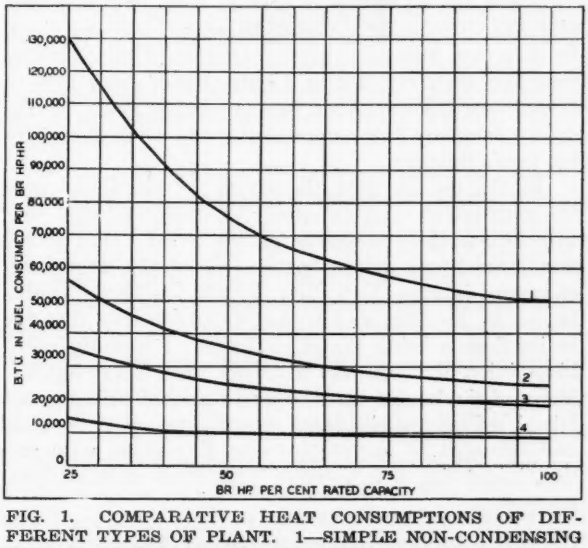


FIG. 1. COMPARATIVE HEAT CONSUMPTIONS OF DIFFERENT TYPES OF PLANT. 1—SIMPLE NON-CONDENSING CORLISS ENGINE; 2—COMPOUND CONDENSING CORLISS ENGINE; 3—STEAM TURBINE; 4—DIESEL ENGINE

Some time ago the Atlantic Sewage Co. abandoned its steam plant in favor of electric driven pumps direct connected to motors, excepting the 12, 14, 15 and 16-in. pumps, each of which was belted to a motor. The old steam plant was held in reserve as a standby unit. Power was purchased at 1.9 cents per kw-hr. which included a demand charge. At this rate the cost of pumping sewage was $4.85 per million gal.

Early last year the company decided to install a Diesel engine for reserve purposes and dispose of the old steam plant. A 250-hp. unit direct connected to a 20-in. pump was purchased and placed in operation. The unit, instead of being used as a standby, has been in almost constant service since its installation at a cost of $1.30 per million gal. pumped which represents a saving over purchased power of $3.55 per million gal. If Diesel power were used exclusively in this plant the daily saving would amount to over $100.00 per day.

*Combustion Engineer, City of Akron, Ohio.

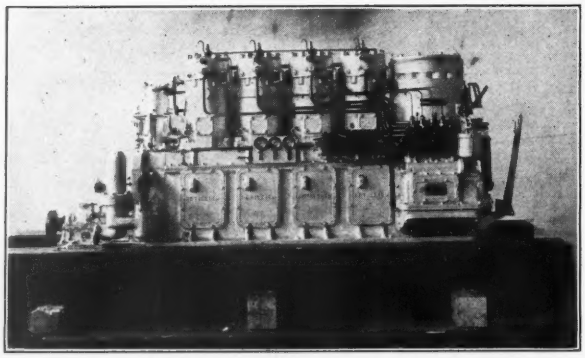


FIG. 2. BETHLEHEM 2-CYCLE MARINE TYPE DIESEL ENGINE EQUIPPED WITH SEPARATE CYLINDER FOR SCAVENGING AIR

Sometimes reduction in cost of electricity is accomplished indirectly by the establishment of a Diesel plant. In Kearney, Nebraska, the installation of Diesel water pumping units resulted in a reduction of from 11½ to 1 cent per kilowatt-hour in the charge made by the utility company that supplies the city with electricity for street lighting.

In the marine field the saving of the Diesel over the usual steam unit is equally as great and this year will witness the appearance on the Great Lakes of the first large Diesel driven boats. One of the largest tug operators in New York City installed a Diesel engine in one of his tugs and it was so satisfactory that the entire fleet is being Diesel equipped. I recently asked his opinion of steam and his reply was "never again." Many of the largest trans-oceanic lines are bringing out Diesel driven vessels. One recently launched in Italy and intended to operate between European ports and the United States is powered with three units of 6000 hp. each.

Combined Steam and Diesel Plants

Standby service is one for which the Diesel engine is peculiarly adapted because it can stand idle and cold for long periods and still be ready to deliver its full power within two minutes after starting up.

We frequently hear engineers remark that only steam power should be used where steam or hot water is needed. This statement is justified only under those conditions where all exhaust steam is used all the time. Only under these conditions does the steam plant utilize more heat than any other form of power. A check of the power field will show how few plants are operating under these conditions.

The possibility and degree of economy in the several classes of plants mentioned is interesting. In plants where high pressure steam is required for other than power purposes, steam will usually, although not always, be found to be the most economical. In this case, when we figure costs, the power and non-power requirements should be segregated and the power item figured as a steam or Diesel plant. To the power cost should be added the cost of producing non-power steam either by additional boiler equipment or, in the case of Diesel power, by waste heat boilers fed with preheated jacket water and heated by Diesel exhaust gases, fuel oil being used when makeup heat becomes necessary. Where non-power steam is required only in small quantities, the overall efficiency or economy will be higher in the Diesel plant.

Where steam turbines are used with Diesel engines, authorities agree that the two types of units together form an ideal combination, assuring high economy under all load conditions. In a plant of this kind, the Diesel units are operated constantly at full load during the peak periods and the turbines carry large overloads if necessary during periods of maximum demand. With this plan of operation the steam end of the plant consumes only a small amount of fuel per kw-hr. of steam operation. The expense of banked fires can be kept at a minimum by utilizing the exhaust gases and jacket cooling water from the Diesels for keeping the boiler water hot and ready to furnish steam quickly on demand.

Diesel Power Plant Costs

Belief is general that the cost of a Diesel plant is much greater than that of a steam plant of an equal size. It is true that a Diesel engine costs more than a steam unit of equal capacity but it must be remembered that a Diesel engine is a self-contained unit and involves almost no additional cost for accessories. The steam unit, however, represents only about one-fourth of the total cost of the plant including building and land.

The Diesel plant requires much less building volume and land area than a steam plant and practically the only necessary accessory is the storage tank for fuel.

It is hard to determine just what the life of the Diesel is but 95 per cent of the engines installed since 1900 are still in operation, their efficiencies remaining the same as originally and, when given intelligent care, they will operate for weeks or months without a shutdown. Two sources of heat loss alone exist in a Diesel plant; they are due to the exhaust gases and the cylinder cooling water. Under the worst conditions the Diesel efficiency will be approximately 30 per cent and with waste recovery this may be raised to at least 60 per cent.

Fuel Consumption of Diesel Engine

Not only does the fuel consumed by a Diesel engine occupy smaller volume but it also weighs much less

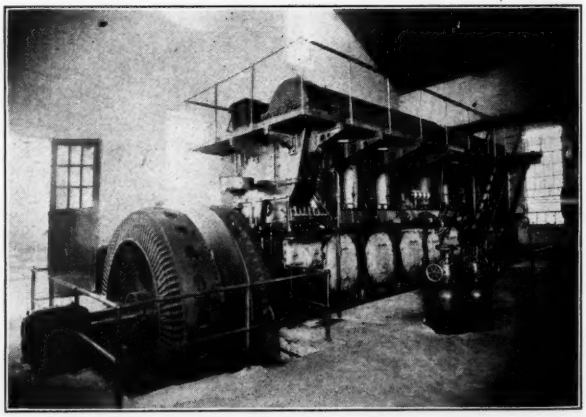


FIG. 3. 1125-HP. WORTHINGTON DIESEL ENGINE USED AS STANDBY IN CONNECTION WITH NATURAL GAS ENGINES IN FREDONIA, KANSAS, PORTLAND CEMENT CO. PLANT

than coal of an equal heat value. Because of the higher efficiency of a Diesel engine, also, a given amount of work is done with a lower number of heat units. Even in the smaller sizes a horsepower-hour is developed on less than ½ lb. of fuel per hp-hr. Figure 1 which was plotted from actual tests, shows the comparative heat consumption per horse-power-hour of steam and Diesel plants of 500-hp. capacity. Notice the much higher economy of the latter at all loads but especially at light loads.

Advocates of steam power and of purchased electric power both admit the low cost of Diesel operation but claim maintenance costs to be high. I have investigated several hundred Diesel plants, operating over a period of years and, except in rare cases, I find the maintenance costs to amount to only a few dollars for repairs for such items as gaskets or plungers for fuel oil injection pumps. Reports were received from 144 plants which have been in operation from one to eleven years, with an average of five years; the average cost for repairs, in many cases including the cost of a service man, was found to be $55.72 per year.

Diesel Engines Are Reliable

Any power supply to be economical must be reliable, for cost of service interruption soon offsets savings. Diesel engines meet this requirement. Continuous runs of six months without a stop are found to be common.

As an example of reliability of action, the history of a 562-hp. Worthington Diesel engine installed in the Horton, Kansas, municipal water and light plant as given by the present superintendent, is interesting. After a 2-months continuous run following the starting up of this engine, it was stopped in order to put two gaskets in the governor to prevent oil leakage. The engine then ran continuously 201 days when, due to carelessness of an operator, the injection air pressure was allowed to drop too much, causing a spray valve tip to be burned off. A new spray valve was put in with a loss of only three hours' time.

After another continuous operation of about two months, the engine was shut down for general cleaning and the valves were changed. Since starting up almost 11 months before, the engine handled the entire load which varied from 30 kw. during the night to 300 kw. during the day and evening. There was no particular reason for running the engine continuously except that no reason appeared for stopping it and after a run of

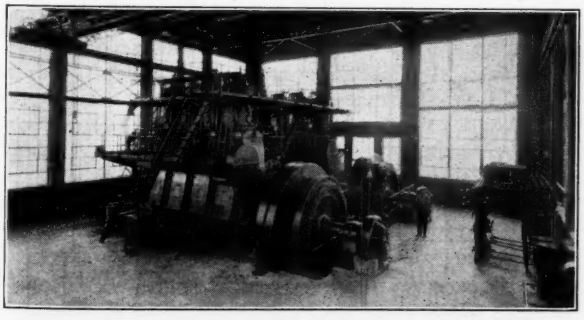


FIG. 4. ONE OF TWO 750-HP., 4-CYCLE, AIR INJECTION McINTOSH & SEYMOUR DIESEL ENGINES THAT HAVE BEEN GIVING EXCELLENT SERVICE FOR THE PAST SIX YEARS AT THE RED STAR MILLING PLANT IN WICHITA, KANSAS

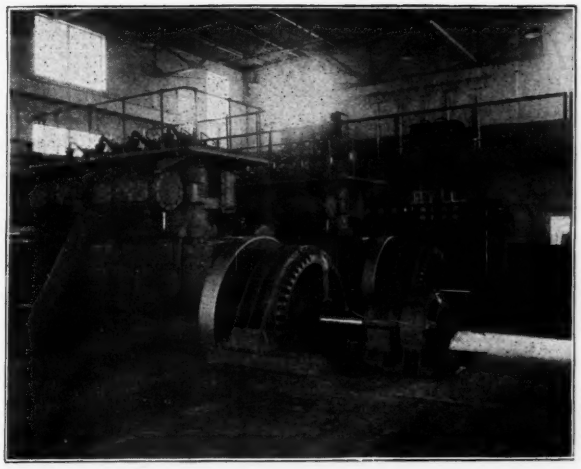


FIG. 5. 1120-HP. FAIRBANKS-MORSE DIESEL POWER PLANT BUILT AT WHITEWRIGHT, TEXAS, IN 3½ MONTHS

a couple of months the operators were curious to see whether any serious reason for shutting it down would develop.

Of 28 plants which have been in operation from 1 to 10 yr., only one reported a shutdown for any great length of time due to Diesel engine trouble. This plant was shutdown for three hr. Three other plants had shut down due to engine trouble for from 10 to 15 min. Several of the plants reported units had operated from 500 to 2500 hr. without a stop and one plant reported a 3460-hr. continuous operation at full load.

Third National Fuels Meeting

Third National Fuels Meeting, which will be held in Philadelphia, Pa., October 7-10, 1929, will follow the same lines as the first and second meetings, which took the form of a fuels forum, according to a recent announcement by the American Society of Mechanical Engineers. In fact, a special effort is being made this year to include recommendations of societies other than the A. S. M. E. as the most effective manner in which the interest of fuels men in general will be served.

The following subjects will be treated at Philadelphia, it is announced: Economics of reclamation of anthracite culm, burning refuse fuels, low-temperature carbonization, the atomic basis of combustion theory, economics of gas, coal and oil fuels, economics of oil production, heat value of fuel, coal pre-treatment, slag accumulations on boiler tubes, air needed for combustion of different fuels, design of furnace for tunnel kilns, development of refractories to meet needs of users, producer gas in brick kilns, fuel burning in ceramic and lime industries, application of fuels in the cement industry, burning pulverized anthracite, recent developments in stoker design (four papers), burning coarse coal in suspension, proper methods of pulverized fuel sampling, low-temperature coke for marine service, pulverized fuels in marine practice, methods of recording smoke (three papers), the effect of pulverized fuel ash on the penetration of ultra-violet rays, smoke abatement at Salt Lake City. At least an entire day will be devoted to smoke abatement, with four additional papers on the general situation.

Protection of

TRANSMISSION LINES by Means of Balanced Relays

PART II.* PRINCIPLES OF OPERATION AND METHODS OF APPLICATION OF CURRENT DIFFERENTIAL RELAYS. BY E. H. STIVENDER, ENGINEER, DIXIE CONSTRUCTION CO.

PARALLEL POWER FEEDERS are generally protected by two classes of relays: current differential relays and reverse power relays. In most cases, the former do not operate satisfactorily at the receiving end of two parallel lines, for they depend for their operation on unbalanced currents and will not operate on a reversal of current if it is of the same magnitude in both elements. As an illustration, when two feeders serve a common load from a common source and a phase to phase short circuit or ground occurs in one feeder, power will still be flowing from the generating station in both lines, while at the receiving end power will be flowing to the load in the good line and from the load toward the short circuit in the defective line. If there is no source of power great enough at the load end to feed back into the short circuit with the power of the good line and thereby to create unequal currents in the two lines of sufficient magnitude to appreciably unbalance the differential relays, the overload relays alone must be depended upon to open the circuit breaker and, in the above case, where an equal overload is in each line, both lines would be disconnected. For this reason, current differential relays are employed at the receiving end only when there are more than two parallel feeders or where there is a synchronous load or other source of temporary power at the load end: reverse power relays must be used where the conditions are otherwise.

Part I of this article dealt with current line differential relays of the General Electric Co. The following is a discussion of current differential and reverse power relays of the Westinghouse Electric & Manufacturing Co. All diagrams show the positions taken by the pallet switches when the circuit breakers are in open position.

Figure 7 is an elementary diagram illustrating the construction of the Westinghouse current differential

*Part I of this article appeared in the July 1, 1929, Issue.

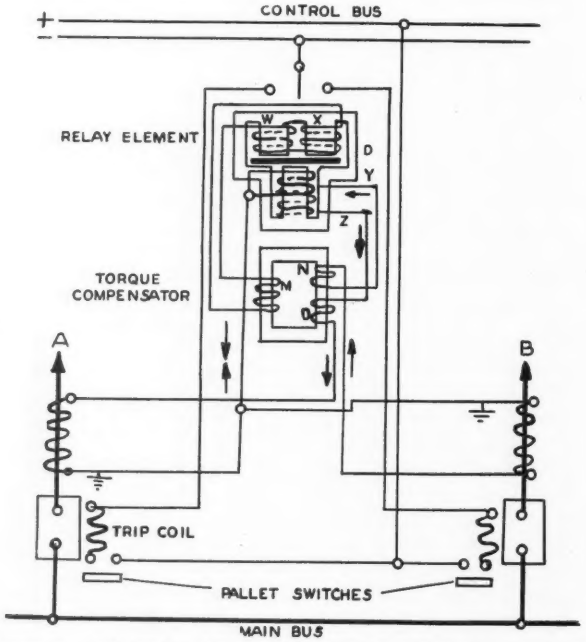


FIG. 7. DIAGRAM OF CURRENT DIFFERENTIAL RELAY AS APPLIED TO TWO PARALLEL FEEDERS

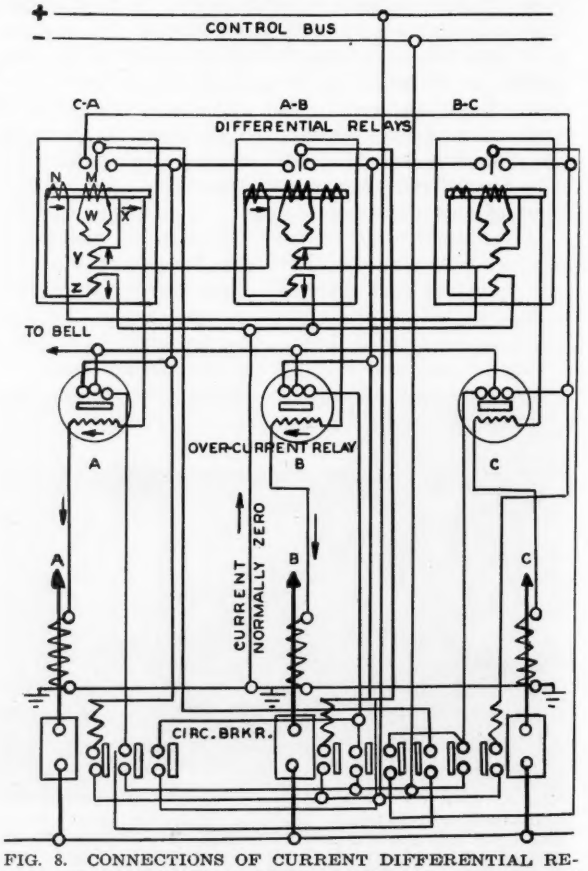


FIG. 8. CONNECTIONS OF CURRENT DIFFERENTIAL RELAY IN COMBINATION WITH OVERLOAD RELAYS ON THREE PARALLEL FEEDERS, AT GENERATING END

relay with the usual connections of this instrument when applied to the protection of two parallel feeders. For simplicity some diagrams concerning this instrument show only one corresponding phase of each feeder.

This relay has two elements: the torque compensator and the relay element. The service of the torque compensator is in requiring the relay operating current to be doubled when one feeder is disconnected, a distinctive feature of this relay. The relay element resembles that of a single-phase induction watt-hour meter, being composed of a core of specially-shaped laminated steel punchings acting upon a rotating disc which carries the contacts of the circuit breaker trip circuit. Permanent magnets are used for retarding the disc to produce the time element as in watt-hour meters. A spiral spring holds the moving contacts midway between the stationary contacts; this spring also carries the control current. There are no gears in this relay, the moving contacts being fastened rigidly to the disc shaft. Operating current adjustments are made by contact screws on a tap plate, the various positions of which change the number of effective turns in coils Y and Z; as in induction time limit overload relays, extra screws are provided to simplify changing taps without opening the current transformer secondary circuit. The time required to operate is varied by changing the positions of the stationary contacts. In induction relays of this company an internally-contained, auxiliary relay is provided to carry the trip current, thus relieving the initial contacts of maximum trip current.

The usual current setting for this type of relay is from 125 per cent to 150 per cent of normal full-load current of each line and a time setting of from 0.2 to 0.5 second. The standard instrument has time adjustments of from instantaneous to 0.5 seconds, varying inversely with the load.

Where two lines have a fixed difference of impedance greater than two per cent, small current autotransformers are used to make the two forces in the actuating element more nearly equal.

Operation of Current Differential Relay

Referring to Fig. 7, the currents of both feeder current transformers assist one another through coils N and O of the torque compensator and oppose one another in coils Y and Z of the relay element. By this method the current of secondary coil M continually flows through the two coils W and X which are in series and complete the field circuit of the relay element while the forces of Y and Z are neutralized and produce no flux in their common core, therefore there is no torque on disc D under normal load conditions. If a short circuit occurs on feeder A, the opposing fluxes of Y and Z become unbalanced and Z causes the disc to turn in the direction to close A circuit breaker trip contacts. When A feeder is disconnected, coil O of the torque compensator is deënergized and M now delivers only one-half the normal current to W and X, thereby preventing the disc from closing B contacts until twice normal load is taken by feeder B. This feature renders unnecessary the use of a series interlock of the control bus current through the circuit breaker pallet switches, besides eliminating the use of separate overload relays in cases where both feeders are capable of carrying double full-load current for a short time. Another advantage is in cases where one feeder is unexpectedly tripped out at the receiving end, in which case there is no danger of the other feeder being disconnected by differential relay operation at the generating end. Furthermore, the possibility of applying independent overload relays is not sacrificed by this construction, their use being necessary where the feeders are not of great enough capacity to carry double load.

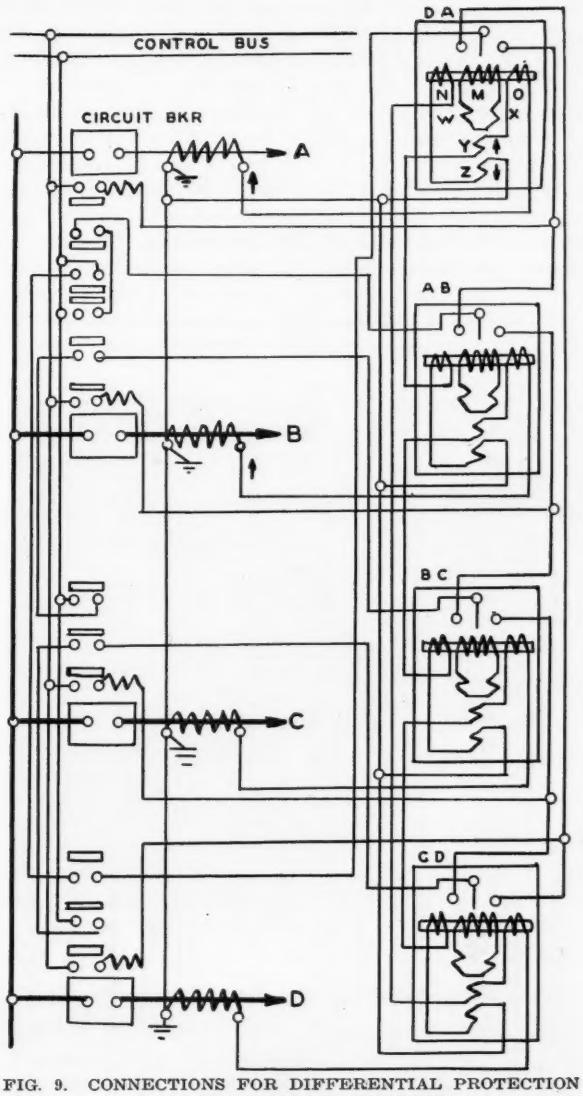


FIG. 9. CONNECTIONS FOR DIFFERENTIAL PROTECTION OF FOUR PARALLEL FEEDERS

Differential Relay Combined with Overload Relay

Figure 8 illustrates schematically the connection of this relay in combination with overload relays to afford differential and inverse time limit overload protection of three parallel feeders at the generating end. The connection shows bell alarm service from an extra contact on the overload relays; the differential relays of this company also contain extra contacts, which are not shown.

Pallet switch interlocks are employed where it is desirable to keep the unaffected feeders in service when all are supplying a mutual heavy overload.

Should a fault occur on feeder A, control current

flows from positive bus through the pallet switch and trip coil of circuit breaker A, A contacts on relay C-A, the pallet switches of circuit breakers A and C in series and to negative bus; current can also flow through A contacts on relay A-B and through the pallet switches of circuit breakers A and B in series to negative bus. When A circuit breaker trips and B and C feeders are carrying more than twice normal full load, B contacts on relay A-B and C contacts on relay C-A close but, since both trip circuits are interlocked through A circuit breaker pallet switch, which is now open, circuit breakers B and C will remain closed and still have differential protection from relay B-C. Should feeder B or or feeder C trip out, the remaining feeder will have overload protection.

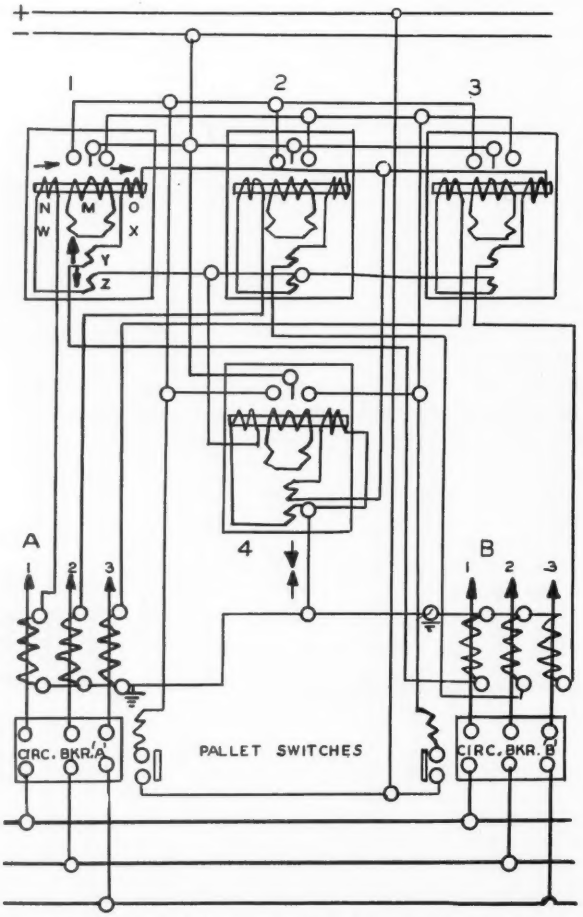


FIG. 10. TWO PARALLEL LINES PROTECTED BY RESIDUAL RELAY 4 IN CONJUNCTION WITH STANDARD RELAYS 1, 2 AND 3

Differential Protection of Four Parallel Feeders

Figure 9 shows the connections employed for the differential protection of four parallel feeders. Straight overload protection is not shown. The operation sequence is the same as for three feeders; A is balanced against B, B against C, C against D and D against A. This system will afford complete balance protection on the three remaining feeders after any one feeder trips out and will afford balance protection on two remaining feeders after two have been tripped only when the two which remain are adjacent; A and D are considered adjacent.

Consider the case in which feeder A trips out on short circuit. Then relays B-C and C-D will give differential protection to feeders B, C and D; now, if feeder B should trip out, relay C-D will still afford balance protection of the remaining feeders in the same manner as explained for the three-feeder system of Fig. 8. But, if feeder C should be tripped out while A is disconnected, there will be no balance protection for feeders B and D. This is evident from the fact that relays D-A and A-B depend on current from feeder A for balancing and relays B-C and C-D depend on current from feeder C. Thus, when two alternate feeders trip out, all the relays are rendered inoperative and overload relays must then be depended upon for protection, when current differential relays are used on four parallel feeders. In all cases, protection of three-phase feeders requires one relay per phase.

Use of the Residual Relay

In some cases it is desirable to protect against overloads that occur from relatively high resistance short circuits to ground; these, if allowed to remain energized, may cause more serious disturbances than if the current is immediately discontinued, as when insulators flash over due to disurbances from induced surges during thunder storms. Sometimes these short circuits are of too small a value to operate standard line balance relays and more sensitive relays are used which are called residual relays. Figure 10 illustrates a system in which two parallel lines are protected by a residual relay. Only one relay of this type is necessary for ground short circuit protection of two parallel feeders.

As can be seen from the diagram, the residual relay 4 is of the same construction as the standard relays but, in practice, it will operate on a much lower degree of unbalance and in less time than the standard relays. Its operating principle is that, on balanced three-phase, star-connected systems, there will be no current flowing in the neutral wire; since the two elements of this relay are connected in the corresponding neutral circuits of the current transformers and elements of the standard relays 1, 2 and 3, there will be no current flowing through the residual relay. Therefore, with a balanced overload on either feeder, the residual relay will not operate; but if a ground should occur on either feeder, current will flow through this relay and trip out the circuit breaker controlling the faulty line. With this connection, the residual relay current and time elements can be set independent of the standard relays and made to operate instantaneously if desired. The contacts are connected in parallel with those of the standard current differential relays.

This system is particularly useful for protection of systems that employ a permanent fixed resistance between the transformer neutral bus and ground.

(To be concluded)

In steam, the heat content depends upon the temperature and pressure, and the amount of heat available for conversion into work will depend upon the back pressure of the engine or turbine; the lower the pressure the more heat there is available for conversion into work.

Supervisory Control and Telemetering Equipment

NEW INSTALLATION PERMITS REMOTE OPERATION OF ENTIRE SWITCHING STATION FROM DISPATCHING STATION. BY T. J. WELLS*

BRONX GAS & ELECTRIC CO. has installed a synchronous selector supervisory system to control its Laconia Avenue alternating-current switching station from the St. Peter's Avenue dispatching station. This is the first installation of synchronous selector supervisory control and telemetering equipment in the City of New York.

This installation consists of three complete supervisory equipments, one for the control and indication of existing apparatus, one for the control and indication of future apparatus and one for selecting either one of 24 remote meter readings. With it an operator is able to

*Switchgear Engineering Dept., General Electric Co.

FIG. 1. RECTIFIED CURRENT TELEMETERING TRANSMITTER FOR REMOTE STATION. A METER IS THE ONLY APPARATUS NEEDED IN DISPATCHER'S STATION

FIG. 3. OPPOSITE SIDE OF BOARD SHOWN IN FIG. 2

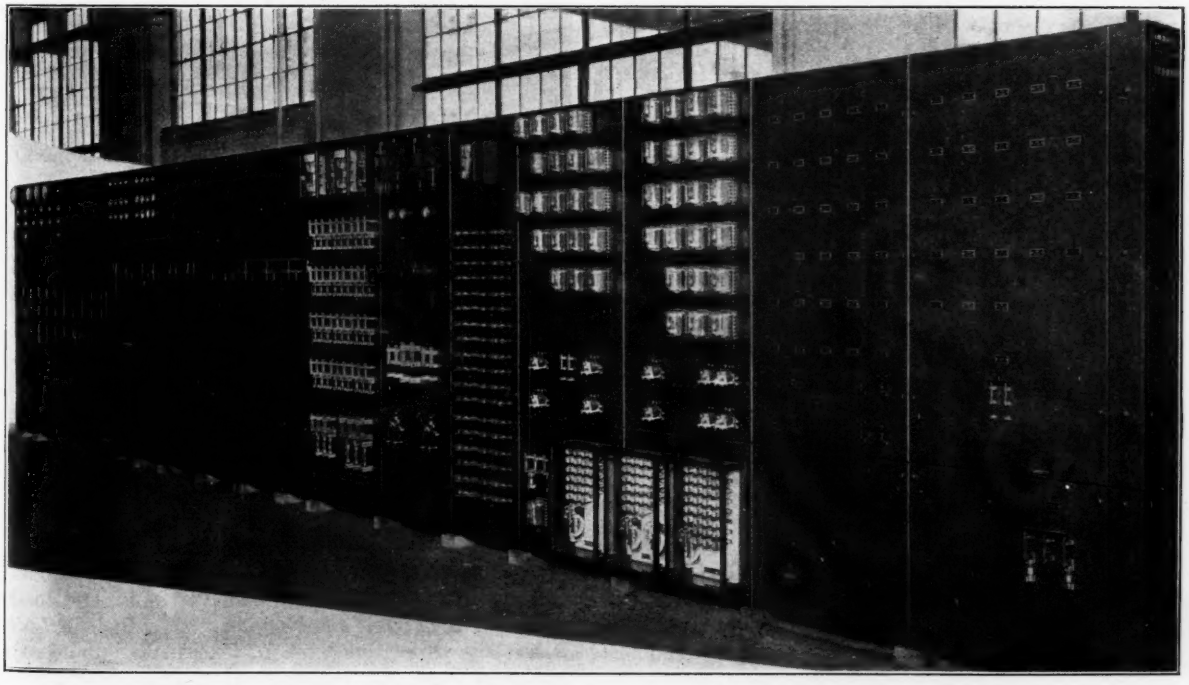


FIG. 2. FRONT VIEW OF ONE SIDE OF LACONIA STATION BOARD SHOWING SUPERVISORY EQUIPMENT

adjust voltage at remote points and at the same time note the changes on the system by reading the dial of the telemeter. Two sets of control cables are used to give continuity of service in case of a failure on one line.

At present, 30 oil circuit breakers, seven induction voltage regulators and two battery charging equipments are being controlled and indicated over four line wires between stations. Forty-nine oil circuit breakers and six induction voltage regulators will be added to the installation later and will be operated by the spare supervisory equipment above mentioned.

The third supervisory system provides for remote metering. This system also requires four line wires. By means of this system, in conjunction with the rectified current telemetering equipment, the dispatcher may receive one at a time any reading of current or voltage on either phase of two three-phase incoming lines. When the additional equipment is installed 12 more readings will be made, making a total of 24.

The Bronx Gas & Electric Co. has leased from the telephone company two sets of cables connecting the two stations over different routes. This is done to guard against a shut-down of the system in case of a telephone cable failure. Necessary equipment is incorporated in the control at the dispatcher's station to switch either of the supervisory control equipments or metering equipment from one set of cables to the other in case of line failure.

By means of the supervisory system, the dispatcher may open or close any of the oil circuit breakers in the Laconia Avenue Station. He may start or stop the battery charging equipments or operate the induction voltage regulators to obtain proper line voltage. Indication of these operations will be received. By selecting the particular line which he is regulating on the supervisory equipment for remote metering, he may watch the voltmeter or ammeter reading and thereby determine when he has secured the proper setting of the regulator.

Drag Scraper Removes Ash Economically

ONE MAN REMOVES DAY'S RUN OF ASH IN HALF AN HOUR. IT USED TO TAKE TWO MEN ALL DAY

DRAG SCRAPERS are extremely flexible, making them easily adapted for storing and reclaiming or handling brick materials under unusual conditions. A recent installation made for ash handling in a large paper products plant at Philipsdale, R. I., is of interest because it is extremely simple and has effected a considerable saving in the cost of ash removal.

This installation shown in plan and elevation, Fig. 1, consists of a ½-yd. Sauerman drag scraper driven by the belted-driven power unit shown in Fig. 2. Ash from a battery of boilers are dropped directly into a tunnel which runs the full length of the boiler room or about 110 ft. This tunnel, 5 ft. 3 in. deep and directly under the boilers, is 7 ft. 6 in. wide at the top and just the width of the scraper at the bottom. Leaving the tunnel, the path of the scraper is continued up an incline to a truck loading hopper. Including the ramp, the span of the scraper is about 200 ft.

Operating cables are carried from the scraper to the two drums of the hoist by guides and fleeting blocks as shown in Fig. 1. Standing by the levers of the hoist, Fig. 2, the operator can look through the window and watch the bucket as it climbs the incline, dumps and returns to the ash pit.

According to George Hawley, chief engineer of the plant it used to take two men working 8¾ hr. a day to

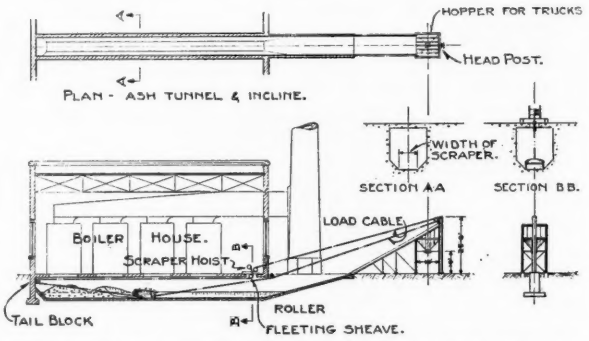


FIG. 1. PLAN AND ELEVATION SHOWING THE DETAILS OF THE OPERATING TUNNEL

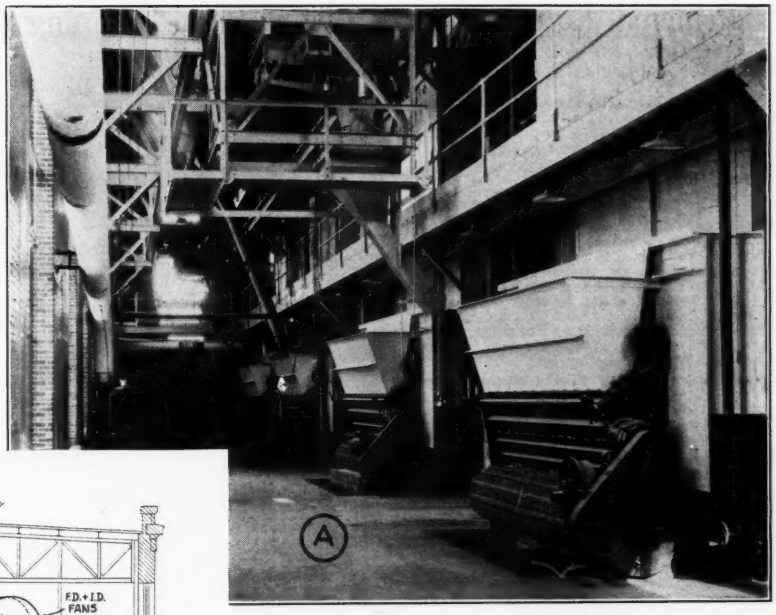
FIG. 2. FROM HIS POSITION AT THE HOIST, THE OPERATOR CAN WATCH THE BUCKET THROUGH THE WINDOW

remove the ash from the plant in wheelbarrows. The ash were piled up in the yard outside the plant and there was the additional expense of reloading them into trucks. One man, using the drag scraper, now removes the same amount of ash in half an hour and the ashes are delivered direct to a hopper when they can be loaded in a truck with no further expense.

FORD MOTOR CO.'s factories in the Detroit area report fuel consumption and power production for 1928 as follows:

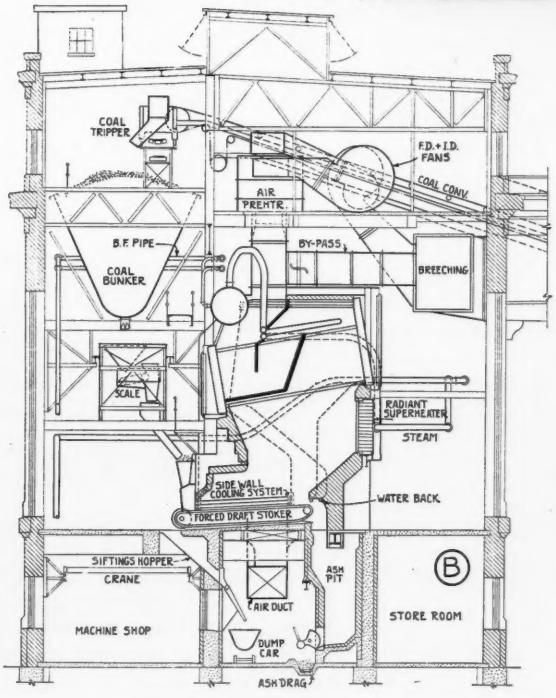
Total fuel consumption at Power Houses Nos. 1 and 3, 637,404 tons, or approximately 12,700 car loads. Steam output, 11,853,000,000 lb. Kilowatt-hours output at the River Rouge plant, 536,944,000, and at the Highland Park and Lincoln plants, 19,347,580, a total of 556,291,580 kw-hr.

New Howard Bend Pumping Station for St. Louis

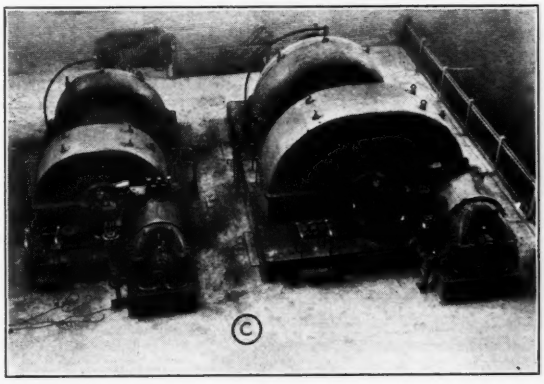


A—Motor-Driven Chain Grate Stokers Serve 4 Boilers of 652-Hp. Each

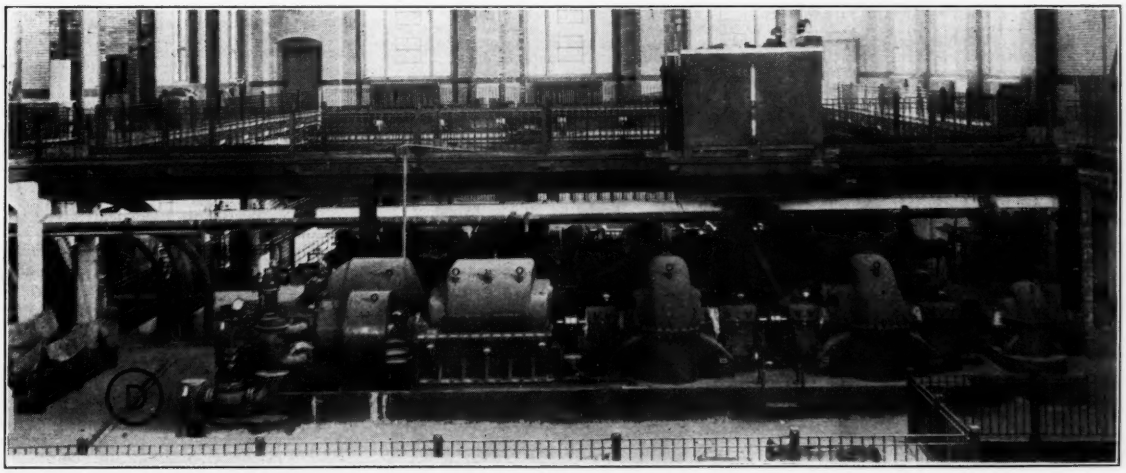
B—Cross-Section Through Boiler Room



C—Low-Head Pumping Units Are Turbine-Driven Through Reduction Gears. Unit at Right is of 120-m.g.d. Capacity



D—High-Head Pumping Units of 30 to 60-m.g.d. Capacity Are Driven Through Gears by Cross-Compound Steam Turbines



Principal Equipment in Howard Bend Pumping Station, St. Louis, Mo.

BOILERS AND AUXILIARIES

BOILERS....Combustion Engineering Corp.
Number 4
Type.....Heine, cross drum, water tube
Heating surface.....6521 sq. ft.
Working pressure...375 lb. per sq. in. gage

Guarantees	Rating 100%	150%	200%	250%
Efficiency — per cent	78	78	77	76
Flue gas temp. deg. F. 474	511	550	600	
Draft loss inches .04	.21	.44	.73	

Furnace volume.....2515 cu. ft.
Furnace volume cu. ft. per rated hp...3.9
B.t.u. per cu. ft. furnace volume per hr. (10,400 B.t.u. coal) at 200 per cent rating 23,981
Cost, boilers, superheaters, supports, soot blowers, etc.....$106,000 (four boilers)
Cost of above per boiler hp.....$40.65

SUPERHEATERS.....Foster-Wheeler Corp.
Type.....Convection and radiant heat
Convection superheater—34—2-in. Foster elements, 9 ft. 3 in. long over rings No. 11 ga. tubes with ¾-in. pipe core, 3½-in. C. I. rings.
Radiant heat superheater—Foster F. S. R.H.A. 13 ft. 0 in. wide by 6 ft. 4 in. surface exposed to radiant heat.

AIR PREHEATERS.....Air Preheater Corp.
Type .....Ljungstrom
Number installed 2

PERFORMANCE of air preheaters—
(Note: Figures below based on preliminary estimate of boiler performance which differ slightly from the actual guarantees by Heine.)

Boiler rating, per cent.	100	150	200
Eff. without preheater, per cent	72	74	73
Eff. with preheater, per cent	80.5	83	82.6
Fuel saving, per cent..	10.2	10.4	11.6
Flue gas entering, deg. F. 475	525	575	
Flue gas leaving, deg. F. 212	245	281	
Air entering, deg. F..	80	80	80
Air leaving, deg. F....368	287	404	
Draft loss, air side, in.	0.38	0.64	1.0
Draft loss gas side, in.	0.38	0.64	1.0

Cost (2 preheaters).....$13,305

STOKERS....Combustion Engineering Corp.
Type.....Green forced draft chain grate
Number 4
Area, active grate surface.....162 sq. ft.
Ratio: Grate surface to heating surface 1:40.2
Drive—2-hp., 60-cycle, 440-v., 3-phase, Louis Allis variable delivery motors
Air at 250 per cent boiler rating—24,375 c.f.m. at 70° F. and 1 in. static pressure.

Cost of 4 stokers.....$29,995

FORCED DRAFT FANS..B. F. Sturtevant Co.
Type—No. 90 Silent Vane, double wheel double inlet.
Number installed 4
Capacity.....24,000 c.f.m., 110 deg. F.
Static head.....3 in.
Speed .....900 r.p.m.
Drive .....Westinghouse motor

INDUCED DRAFT FANS.B. F. Sturtevant Co.
Type.....No. 1001 T.V. I.D. fan
Number 2
Capacity.....27,500 c.f.m. at 285 deg. F.
Static pressure.....2.3 in.
Speed .....575 r.p.m.
Drive .....Westinghouse motor
Cost of 4 forced and 2 induced draft fans $12,554

SUMMARY, BOILER COSTS—

Item	No.	Cost Total	Per B.hp.
1. Boilers, superheaters	4	$106,000	$40.65
2. Stokers	4	29,995	11.50
3. Settings	4	43,209	16.55
4. Air preheaters..	2	13,305	10.20
5. Forced draft fans*	4	4,854	1.86
6. Induced draft fans*	2	7,700	5.90
7. Breeching, duct work †all boilers		18,000	6.90
Total per boiler hp. 1+2+3+4+5+6+7			93.56
Total per boiler hp. 1+2+3+5+7.			77.46

*5 and 6 lump sum bid, separated on basis of weights.
†Engineers estimate.

PUMPING EQUIPMENT

CRANE, HIGH-PRESSURE PIT.....
...Milwaukee Electric Crane & Mfg. Co.
Capacity .....20 t.
Lift .....45 ft. 0 in.

CRANE, LOW-PRESSURE PIT.....
...Milwaukee Electric Crane & Mfg. Co.
Capacity .....20 t.
Lift .....65 ft. 0 in.
Cost—two 20 t. crane 90 ft. and 75 ft. span $23,450

HIGH HEAD PUMPING UNITS.....
.....De Laval Steam Turbine Co.
Number installed 2
Capacity .....30—60 m.g.d.
Head .....316 to 360 ft.
Type—Cmpd. steam turbine geared to two sgl. stage pumps in series.
Max. brake horsepower.....4460
Max. speed, hp. turbine.....4500 r.p.m.
l p. turbine.....3460 r.p.m.
pumps ..... 596 r.p.m.
Average annual duty.163.6 ft. lb. per B.t.u.
Best duty guaranteed (at 50 m.g.d., 336 ft. head) .....168.0 ft. lb. per B.t.u.
Cost of two high head units erected.....$272,000
Cost per br.hp., approx.....$30.00
Efficiency of pump, 60 m.g.d.,
360 ft. head.....85 per cent
40 m.g.d., 316 ft.....84 per cent
45 m.g.d., 325 ft.....85 per cent
50 m.g.d., 336 ft.....86 per cent

CONDENSERS.....C. H. Wheeler Mfg. Co.
Sq. ft. condensing surface.....6700
Dia. gage, and length of tubes.....
....1 in. o.d., No. 18 B.W.G., 18 ft. 2 in.
Number of passes.....2

AIR EJECTOR.....C. H. Wheler radojet
Number stages.....2
Cap. lb. air per hr. at 1½ in. abs. pressure 80

CONDENSATE PUMP .....
.....De Laval Steam Turbine Co.
Size.....4 in. centrifugal
Speed .....2200 r.p.m.

CIRCULATING PUMPS .....
.....De Laval Steam Turbine Co.
Number 2
Drive.....Main pump shaft

GENERATING EQUIPMENT

GASOLINE-ENGINE-DRIVEN GENERATING UNIT.....Sterling Engine Co.
Generator and exciter.General Electric Co.
Number 1
Capacity .....
..112.5 kv-a., 90 kw. at 80 per cent p.f.
Speed .....1200 r.p.m.
Cylinders.....6, each 5¾ in. by 6¾ in.
Cost of 1 unit, complete with gasoline storage tank, exhaust silencers, etc.$7927

TURBINE-DRIVEN GENERATING UNITS....
.....Moore Steam Turbine Co.
Generator.....Allis-Chalmers Mfg. Co.
Condensing equipment .....
.....Worthington P. & M. Corp.
Number 2
Capacity, each...300 kw. at 80 per cent p.f.
Bled steam .....
.....9000 lb. at 50 lb. per sq. in.
Water rate full condensing 27 in. vac. 300 lb. 200 deg. F. sup.,
at 150 kw.....18.7 lb. per kw-hr.
at 225 kw.....17.1 lb. per kw-hr.
at 300 kw.....16.6 lb. per kw-hr.
Speed .....3600 r.p.m.
Price, 2 turbines and generators.$29,304.00
CONDENSERS, sq. ft. surface, each.....579
Price, including one motor-driven condensate and circulating pump, one steam turbine-driven condensate and circulating pump, two expansion joints, two air ejectors, two exhaust relief valves $6875

LOW-PRESSURE PUMPS

LOW HEAD PUMPING UNITS.....
.....De Laval Steam Turbine Co.
Number 3
Capacity....Two 60 m.g.d., one 120 m.g.d.
Head—Min. .....19 ft.
Max. .....50 ft.
Average .....40 ft.
Type—Impulse steam turbines geared to sgl. stage centrifugal pumps.
Cost (three units).....$208,000
Cost per br.hp. approx.....$104.00

	60 m.g.d.	120 m.g.d.
Max. br.hp.	480	960
Max. speed, turbine...	6000	6000
Max. speed, pump....	299	226
Average annual duty.	133.7	142.9
Best duty guaranteed.	136.6	145.9

CONDENSERS.....C. H. Wheeler Mfg. Co.
Sq. ft. surface.....1500 2400
Dia. gage, and length of tubes—¾ in. o.d., 12 ft. 2 in. 1 No. 18 B.W.G.
Water passes 2 2

AIR EJECTOR .....
.....C. H. Wheeler radojet, 2-stage
Cap. lb. air per hr. at 1½ in. abs. pressure 40 40

CONDENSATE PUMP .....
.....De Laval Steam Turbine Co.
Size.....2½ in. centrifugal
Speed .....2200 r.p.m.

FEEDWATER EQUIPMENT

BOILER FEED PUMPS .....
..Worthington Pump and Machine Corp.
Number 3
Capacity.....200 g.p.m. against 400 lb.
Speed .....3600 r.p.m.
Drive—Allis-Chalmers motors and Elliott steam turbine.
Cost per water hp.....$47.00

FEEDWATER HEATERS.....Cochrane Corp.
Number.....2, deaerating type
Capacity—65,000 lb. per hr. from 100 deg. F. to steam temp.

EVAPORATORS.....Griscom-Russell Co.
Capacity...2400 lb. distilled water per hr.

OTHER MECHANICAL EQUIPMENT

CENTRIFUGAL STEAM PURIFIERS (4).....
..... Hagan Corp.
GRATING.....Irving Iron Works
COMBUSTION CONTROL....Carrick Eng. Co.
SOOT BLOWERS .....
.....Diamond Power Specialty Corp.
WATER COLUMNS AND ILLUMINATORS...
.....Reliance Gauge Column Co.
PIPING.....Midwest Piping & Supply Co.
INSULATION.....The Philip Carey Co.
VALVES:
Blowoff—Tandem, Type B.....
.....Yarnall-Waring Co.
Steam and Water, high pressure....
.....Chapman Valve Mfg. Co.
Hydraulic...Michigan Valve & Fdry. Co.
Check in hp. main .....
.....Automatic Cone Valve Co.
Safety.....Ashton Valve Co.
Atmos. relief.....Cochrane Corp.
Reducing.....The Fisher Governor Co.
Pressure regulating .....
.....The Fisher Governor Co.
FEEDWATER REGULATORS (Copes).....
.....Northern Equipment Co.
EXCESS PRESSURE REGULATORS.....
.....Fisher Governor Co.
WATER SOFTENER .....
.....Paige & Jones Chemical Co., Inc.
STEAM TRAPS...Armstrong Machine Works
METERS AND INSTRUMENTS:
Steam flow...Republic Flow Meters Co.
CO_2.....Brown Instrument Co.
Water meters (Venturi).....
.....Builders Iron Foundry
Air-flow meters.....Bailey Meter Co.
Pressure gages—Foxboro Co., Crosby Steam Gage & Valve Co., Ashton Valve Co.
STEAM DRIP POCKETS.....Crane Co.
LUBRICATING OIL FILTERS.....
.....S. F. Bowser & Co., Inc.
CENTRIFUGAL OIL PURIFIERS.....
.....De Laval Separator Co.
BOILER BREECHINGS AND DUCTS.....
.....Hamler Boiler & Tank Co.
CHIMNEY AND BOILER SETTINGS.....
.....John Boland Const. Co.
COAL HANDLING EQUIPMENT—
Magnetic Separators, Crusher, etc....
.....Stephens-Adamson Mfg. Co.
SWITCHBOARDS.....Wurdack Electric Co.
ELECTRICAL METERS .....
....Weston Electrical Instrument Corp.
ELECTRIC MOTORS — Allis-Chalmers Mfg. Co., General Electric Co., Louis Allis Co.
SWITCHES AND CIRCUIT BREAKERS.....
.....Condit Electrical Mfg. Corp.
TRANSFORMERS (Pittsburgh) .....
.....Allis-Chalmers Mfg. Co.
TRAVELING SCREENS AT INTAKE.....
.....Chain Belt Co.
SUMP PUMPS.....Dayton-Dowd Co.

Howard Bend Pumping Station was designed entirely by the engineers of the Water Division of the Department of Public Utilities of St. Louis, who also supervised its construction. John C. Pritchard was director of public utilities for the city and Leonard A. Day, water commissioner, was directly in charge of the work. Details of the design of mechanical equipment were handled by H. Clay Henning, division engineer in charge of the operating section.

SULPHUR DIOXIDE

Its Characteristics as a Refrigerant

by W. R. WOOLRICH
Professor of Mechanical Engineering
University of Tennessee
Knoxville, Tenn.

SULPHUR COMPOUNDS were the first refrigerants other than air used in the production of ice. In the earliest machines of William Cullen, the cold was produced by ejecting air from the surface of water, thus lowering the boiling point. The water then boiled, but the vapors produced had to secure their heat of vaporization from the water present. The ejector or vacuum pump exhausted this vapor and the resultant temperature of the water was lowered. As the process continued, the temperature approached that of ice.

In 1810, Sir John Leslie supplemented Cullen's method by exposing the vapors to an additional tank containing sulphuric acid. The affinity of the sulphuric acid for water vapor assisted the process so effectively that a few pounds of ice were produced.

Development of Ammonia Machines Preceded That of Other Refrigerants

No definite strides seem to have been made in advancing the practical production of ice by the use of sulphur compounds as refrigerants until after Linde in Germany and Boyle in America had developed the ammonia compression machine to a commercial reality. This step seems to have aroused experimenters in other fields to action and in the early eighties Pictet produced some interesting results with sulphur dioxide.

While the development of the sulphur dioxide machine has never threatened the supremacy of the ammonia machine on account of certain inherent characteristics of the sulphur dioxide that make it undesirable for low-temperature work, yet there has been a field in which it has rightfully competed for recognition. This has been its application to small refrigerators.

In the accompanying table are shown the more important properties of sulphur dioxide and ammonia.

COMPARISON OF PHYSICAL AND CHEMICAL CHARACTERISTICS OF AMMONIA ND SULPHUR DIOXIDE

	Ammonia	Sulphur dioxide
Weight per cubic foot	42.6 lb.	93.12 lb.
Boiling point	—28 deg. F.	+14 deg. F.
Melting point	—107 deg. F.	—100 deg. F.
Critical temperature	271 deg. F.	315 deg. F.
Critical pressure	1651 lb.	1641.5 lb.
Latent heat of vaporization	589.4 B.t.u.	172.3 B.t.u.
Suction pressure at 5 deg. F	32.27 lb. abs.	11.8 lb. abs.
Head pressure at 86 deg. F	169.2 lb. abs.	65.9 lb. abs.
Specific heat	0.523	0.151
Inflammable	Yes	No
Standard ton refrigeration effect	490.3 B.t.u.	146 B.t.u.
Refrigerant required per ton per minute	0.408 lb.	1.37 lb.

Power needed to produce a ton of refrigeration by the various refrigerants is probably best compared by the standard ton cycle originally presented by Voorhees and later adopted by the American Society of Refrigeration Engineers. While the standard ton cycle probably gives the ammonia certain advantages that are not entirely fair to other refrigerants, it does, no doubt, offer the best available basis of comparison. The accompanying chart shows in outline the standard ton cycle.

By referring to the chart, it will be noted that the refrigerating effect of the sulphur dioxide is 146 B.t.u. This is represented by the vertical height AB. The compressor action of the sulphur dioxide machine in carrying the refrigerant from point B to point C under adiabatic conditions will follow an entropy line of 0.402 until it reaches the standard ton discharge pressure corresponding to a saturated temperature of 86 deg. F. At this point, shown as C on the chart, the total heat will be 216.5 B.t.u.

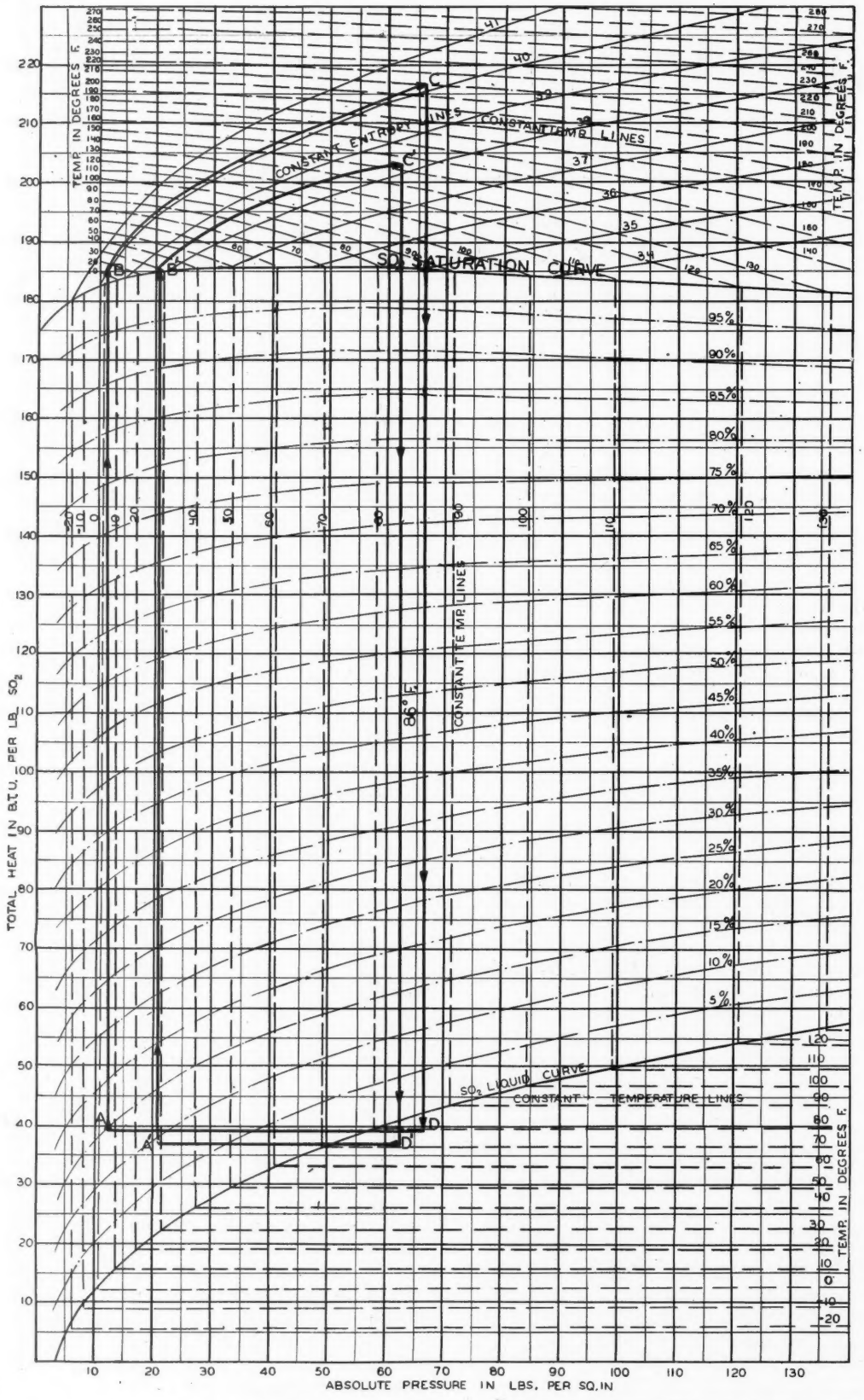
Each pound of sulphur dioxide, therefore, going, through the compressor has received an addition of 216.5 — 185.1 or 31.4 B.t.u.

Standard Ton of Refrigeration Is Equal to 200 B.t.u. per Minute

The next step will be that of determining how many pounds of sulphur dioxide must be circulated under these standard ton conditions to give a ton of refrigeration. By referring to the chart, the refrigerating effect AB represents the addition of 146 B.t.u. Under standard conditions the refrigerant in going through the cooler rises in heat value from 39.1 B.t.u. to 185.1 B.t.u. The pound of heat the sulphur dioxide has picked up therefore is 146 B.t.u.

Since one ton of refrigeration equals 288,000 B.t.u. per 24 hr. or 200 B.t.u. per minute it will be necessary to pump as many pounds of sulphur dioxide under standard conditions as $200 \div 146 = 1.37$ lb.

To determine the theoretical horsepower, it will be necessary to multiply 1.37 lb. by 31.4 B.t.u., the amount



STANDARD TON CYCLE CHART GIVING HEAT VALUES OF SO_2 UNDER DIFFERENT CONDITIONS. ABCD IS THE STANDARD TON CYCLE FOR SO_2

of heat added by the compressor to each pound and to divide this product by the heat equivalent of one horsepower minute. Since the horsepower minute is equal to 42.5 B.t.u., the theoretical indicated horsepower for sulphur dioxide will equal:
1.37 [(216.5 — 185.1) ÷ 42.5] = 1.01 hp. for 1 ton SO_2 refrigeration. This result, 1.01 hp., is only slightly more than the requirement for a ton of ammonia refrigeration under similar conditions, the ammonia requiring 0.979 hp. for one ton of refrigeration.

Summarizing, then, what the chart shows graphically is as follows: AB is the refrigerating effect under standard ton conditions of one pound of SO_2. BC shows the change of physical values of the SO_2 under standard ton conditions when compressed. The projection of the curve BC onto the Y axis represents the heat added by compression. CD is the condenser effect under standard ton conditions of one pound of SO_2. It is equal to the sum of the refrigerating effect and the heat added by the compressor. DA is the expansion valve effect which is, within itself, a constant heat change.

Reaction of Sulphur Dioxide on Metal

Sulphur dioxide has very little reaction on metals. Bronze, steel, brass, nickel and copper are all relatively resistant to pure sulphur dioxide. The danger of corrosion with sulphur dioxide is always materially increased by the presence of water. When water mixes with sulphur dioxide, it forms sulphurous acid which, in the presence of moisture, is highly corrosive to some metals. This corrosive effect alone is a very serious factor in the commercial use of sulphur dioxide in the refrigerating field.

So long as the operating pressures on the suction side are maintained safely above atmospheric pressures, there is little danger of contamination of the sulphur dioxide with water since the pressure within the cylinder is always positive and will tend to produce a leakage outward rather than inward. When the suction pressure drops below atmospheric pressure, however, the leakage of air carries moisture into the cylinder and is most likely to be of serious consequence.

By referring to the comparative table of the properties of ammonia and sulphur dioxide, it will be seen that the ammonia has a boiling point at atmospheric pressure of —28 deg. F. while the boiling point of sulphur dioxide at atmospheric pressure is +14 deg. F.

It is evident, therefore, that if we attempt to do any low-temperature work with sulphur dioxide we may get dangerously near a vacuum condition.

Two precautions should be taken in the development of sulphur dioxide machines to prevent water entering the system. First, the suction piping should be amply large to permit the sulphur dioxide gas to flow freely into the suction side of the compressor. Second, the temperatures used should be such that the pressure within the machine on the suction side will always be positive.

Lubrication of Sulphur Dioxide Machines

Practically all of our early literature indicated that sulphur dioxide was such a perfect lubricant that no other lubricating medium was considered necessary. Later, however, it was found desirable to use lubrication on many of the machines.

Many oils break down readily when required to work commercially under exposure to sulphur dioxide. This has made it necessary to select oils that could be especially treated to be resistant to the action of the sulphur dioxide.

The best of oils, however, must not be expected to stand up under sulphurous or sulphuric acid conditions and when either of these are present some difficulties must be anticipated. This makes it essential to good operation that water vapors be kept out of the circulating system.

Dangers of Sulphur Dioxide to Life

Dangers of sulphur dioxide to human life are less than those from ammonia. The action of the sulphur dioxide gas is rather pronounced on the respiratory organs and will readily suffocate those exposed if they inhale freely; however, it does not have the intense blinding action on the eyes so typical of ammonia and thus does offer the individual more opportunity to escape if any avenue is open.

The non-inflammable nature of sulphur dioxide is a factor well worth weighing in the selection of a refrigerant for refrigeration in homes and apartment buildings.

Examples Showing Application of Chart for Working Typical Sulphur Dioxide Problems

Problem: A compressor that is circulating 6 lb. of sulphur dioxide per minute maintains a head pressure of 62 lb. absolute and a suction pressure of 20 lb. absolute. The liquid coming from the receiver is at 70 deg. F. and at suction is 30 deg. F.

1. What is the value of the refrigerating effect with adiabatic compression?
2. What theoretical tonnage of refrigeration will this value produce?
3. What will be the value of the theoretical horsepower per ton to produce the required compression under the conditions?
4. How much heat must the condenser remove per minute?

Computations: To determine the refrigerating effect for each pound, the 70 deg. F. constant temperature line below the liquid curve will be extended horizontally to the suction pressure ordinate at 20 lb. absolute, or D′ to A′ on the chart. The reason for this line continuing horizontally is that, in passing through the expansion valve, we have a constant heat change until refrigeration starts. The SO_2 atomizes in coming through the expansion valve but only partially vaporizes until it starts taking up heat from the cooler.

The heat value (from the chart) under this condition is 36.5 B.t.u.

The refrigerant now boils and it rises on the chart along the 20-lb. ordinate until it meets the 30-deg. superheat line just above the saturation curve at an entropy value of 0.384 and a total heat value of 185.5 B.t.u.

The total refrigeration effect has been, therefore, 185.5 — 36.5 or 149 B.t.u. per lb; Answer No. 1.

Theoretical tonnage produced by pumping 6 lb. per min. will be: (149 × 6) ÷ 200 or 894 ÷ 200 = 4.47 t. (200 B.t.u. per minute is the equivalent of one ton of refrigeration). Answer No. 2.

To determine the horsepower of compression, it is

necessary to follow up the constant entropy line 0.384 until it meets the 62-lb. pressure ordinate at C′ to determine its total heat after compression. By chart this is 203 B.t.u.

The heat added by the compressor to each pound is then, 203 — 185.5 or 27.5 B.t.u. Since 42.5 B.t.u. per minute is the heat equivalent of one horsepower, the total theoretical horsepower requirements will be (27.5 × 6) ÷ 42.5 = 3.86 hp., Answer No. 3.

The heat that must be removed by the condenser for each pound of SO_2 will be 203 — 36.5 or 166.5 B.t.u.

The total heat that must be removed per minute by the condenser will be 166.5 × 6 = 999 B.t.u., Answer No. 4.

Limitations of the Chart

Similar problems with other conditions can be readily worked from the standard ton chart but under no condition can accurate results be obtained unless the sulphur dioxide is cooled either to or below the liquid line before it enters the expansion valve and heated to or above the saturation line before it enters the compressor. At any other points the sulphur dioxide would be a mixture of liquid and vapor and the percentage of each being indeterminable, the problems dependent upon their value would not permit solution.

Even though the problem would be indeterminable unless the quality were known, the chart indicates what a great difference it will make to the value of the refrigerating effect if the quality of gas going back to the compressor is lowered or if the receiver action is destroyed, permitting gas instead of liquid to pass over to the cooler.

For example, if the quality of gas taken into the compressor is dropped to 85 per cent, or if 15 per cent of liquid SO_2 is pulled into the compressor, the refrigerating effect for standard ton conditions is lowered to 118.1 B.t.u. or 27 per cent.

Likewise, if 15 per cent gas and 85 per cent liquid sulphur dioxide were carried into the cooler instead of sub-cooled liquid, the refrigerating effect under standard ton conditions will be lowered to 121.1 B.t.u. or 17 per cent.

Jet Dispersers for Hydroelectric Plants

Device for Use with High-Pressure Water Jets Distributes Water Over a Large Controlled Area. By John H. D. Blanke

DEVASTATING effects of powerful jets of water are hardly conceivable. Solid rock, masonry, or concrete is rapidly eroded; large holes 30 ft. in depth have been worn in firm rock; water cushions of apparently safe proportions are converted into huge whirlpools, that rotate masses of stones and rocks to grind away the stream bed. A single jet 2 ft. in diameter, for instance, will discharge 7 t. of water per second at a velocity of 80 ft. per sec. under 100 ft. of head and will possess nearly 3000 hp. which must necessarily be expended in one form or another. Common situations in which these conditions occur are at the outlets from impounded waters for irrigation purposes, water supply or hydraulic power; at scour outlets from reservoirs and pipe lines; at emptying valves for hydraulic power penstocks; and at the discharge end of pipe lines generally.

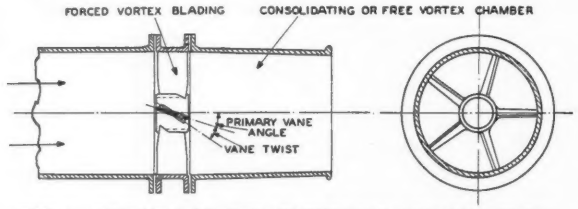


FIG. 1. DETAILS OF THE GLENFIELD JET DISPERSER

Study of this subject of high-pressure water release has been made by Glenfield & Kennedy, Ltd., and as a result they have evolved, patented in various countries and put on the market, the Glenfield Patent Jet Disperser. The purpose of this device is to shatter the jet, and scatter it over a wide area many hundreds of times greater than that covered by a solid jet. In this way, the drops are cushioned against the atmosphere, the formation of the many globules allowing the air to act upon an enormously increased superficial area, and the water falls gently over any prescribed area without causing turbulence, whirling or wave formation. The downstream water advances as a broad steady current fed over a wide area by the falling drops, the whole of

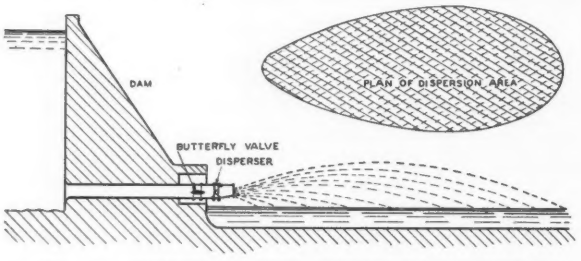


FIG. 2. DISPERSER USED HORIZONTALLY WITH BUTTERFLY VALVE

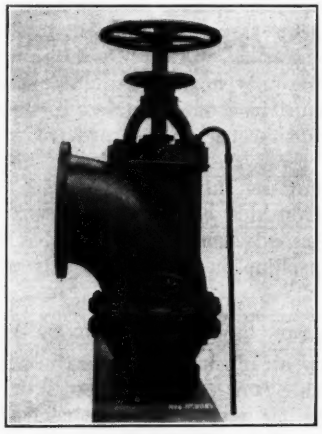


FIG. 3. SMALL DISPERSER COMBINED WITH A NEEDLE VALVE

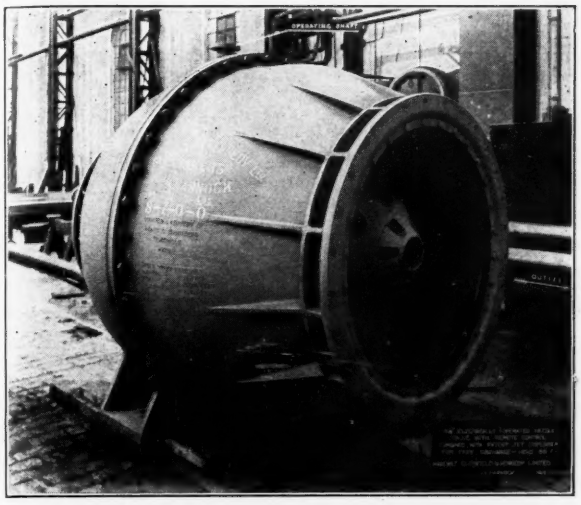


FIG. 4. ELECTRICALLY OPERATED 48-IN. VALVE AND DISPERSER FOR A HEAD OF 85 FT.

the destructive concentrated energy of the jet being dissipated.

The principle of the apparatus is to impart a slight tangential motion or rotation, to the axially traveling jet, the amount of imparted rotation increasing from the periphery towards the axis of the jet, thus producing a free-vortex state in the mouth of the orifice. Methods of imparting rotation to an escaping jet for the purpose of producing a spray has been known for over 40 years and has been applied, usually to small jets, on many occasions. With a large and powerful high-velocity stream, however, it is necessary to disintegrate the jet throughout its whole mass within the shortest possible distance from the escape orifice, a result produced with the Glenfield disperser by the free vortex condition of the jet at exit. Attempting deliberately to form a free-vortex condition in a large and powerful high velocity jet escaping from the end of a pipe is a new idea, constituting a radical departure from all previous dispersing spray nozzles. The free-vortex state, being the natural condition towards which all freely rotating liquids tend, is formed with the minimum expenditure of head so that the addition of a disperser nozzle entails practically no diminution of discharge capacity of the outlet pipe.

Can Be Combined with Other Valves

One design of the disperser, suitable for attaching

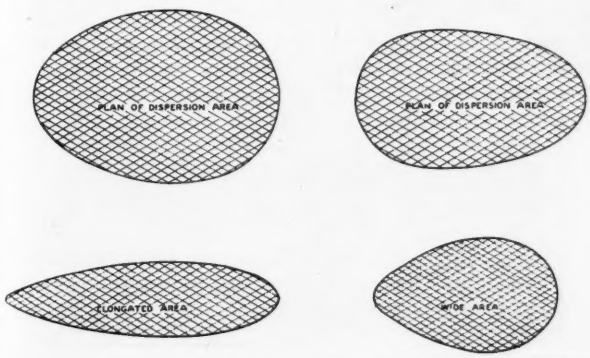


FIG. 5. BY DIFFERENT ARRANGEMENTS, A WIDE VARIETY OF DISPERSION AREAS CAN BE OBTAINED

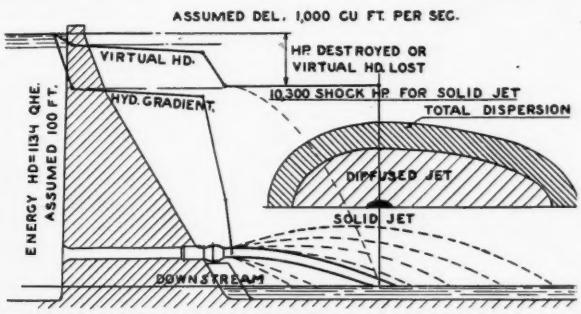
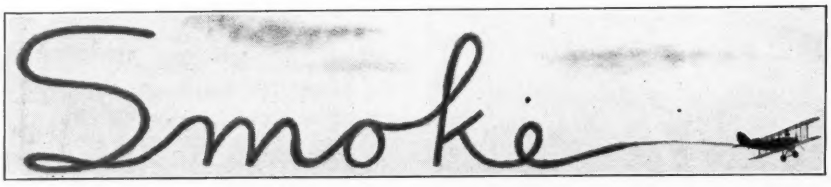


FIG. 6. HYDRAULIC DIAGRAM OF FREE DISCHARGE THROUGH A JOHNSON-BOVING CONTROL VALVE

to a pipe end, shown in detail in Fig. 1, is employed when the outlet is controlled by a shutdown device such as a sluice, a gate valve, or a butterfly valve, as shown in Fig. 2. In cases where a needle valve is employed, the disperser is embodied with the valve in such a manner that dispersion of the jet is equally effective at all positions of valve opening. The principle of design of the disperser element is then identical with that of Fig. 1, therefore providing valuable combination of perfect dispersion, at all rates of flow, with effective regulation of discharge by the needle valve. A small disperser of this type, now operating under 400-ft. head, is shown in Fig. 3. A 48-in. disperser and needle valve for 85-ft. head has been installed at the Mangahao Hydroelectric Plant in the North Island of New Zealand, where it regulates the discharge of stored flood water from an upper dam to a lower dam which is thereby maintained at practically constant level. This valve, shown in Fig. 4, is electrically operated and may be controlled at the site or by distant control; an electrical transmitter shows the degree of opening of the valve, simultaneously at the site and at the control house.

This device permits considerable variation in the shape of the dispersion area covered by the shattered jet, and is readily adaptable to conditions of the outlet end. General shapes of dispersion area are shown in Fig. 5. By simple changes, the design may be elongated or widened as shown. Of particular interest to the hydraulic engineer is the chart shown in Fig. 6. It shows the comparative effect of a free discharge with and without jet dispersion and also illustrates the relative shock areas and shock energies. In order to compare the shock energy at the downstream surface, an impounded head of 100 ft. has been assumed and a rate of discharge of 1000 cu. ft. per sec. A single solid jet under those conditions possesses energy equivalent to about 10,300 hp., the whole of which is dissipated against an air cushion when dispersion is provided. In most practical cases, there would be several such jets from a single dam and in such instances the dispersion areas would be designed to merge into each other and cover the full width of the downstream surface or as much free space as available.

May shipments of domestic water softeners as reported by 20 manufacturers to the Department of Commerce, were 1444 units, with a net sale price of $160,532 as compared with 1604 units in April with a net sale price of $177,041 and 1480 units in May, 1928, with a net sale price of $177,605.



Motion Picture Camera Records Smoke Emissions

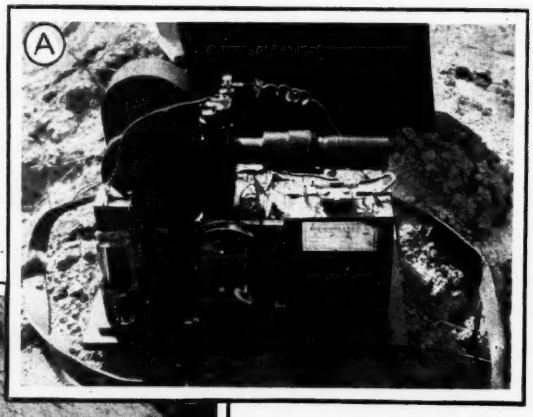
by AUSTIN C. LESCARBOURA

SMOKE LEADS to many controversies and sometimes to legal action. The power house operator, therefore, should know something of how smoke nuisance evidence is secured and presented in a most convincing manner. The old method of bringing a "still" camera into action and taking an occasional photograph, is by no means sound evidence. It is open to question as to whether the photographs have been made at just those rare times when the smokestack might be pouring forth offensive smoke, or whether they represent a fair average of conditions throughout the day.

In order to pin the smoke nuisance evidence down to something quite definite, the faculty of the Stevens Institute of Technology have recently developed an automatic smoke-recording camera. This device exposes hundreds of "frames" of an 18-mm. film in the course of a day, at predetermined intervals, so that when the positive print is projected on a screen at normal speed, an entire day's smoke nuisance is reviewed in a few minutes.

The smoke-recording camera comprises a standard clock-driven hand motion picture camera, such as is employed for amateur filming. The gate of the camera, however, is altered so that the "frames" are reduced to half their normal height, so as to record more exposures per foot. After all, just a narrow skyline is required, showing the offending smokestack or smokestacks and the sky in the immediate vicinity. The camera is set for the single-exposure operation, and the push-button is actuated by an electromagnetic plunger which, in turn, is actuated every 30 sec. or every minute by a clockwork timer. Small B-batteries are employed as the source of current and a considerable flow is required for just an instant to operate the plunger that presses the camera pushbutton. Condensers are employed so that their charge, between impulses, may be stored up and used for a sharp action.

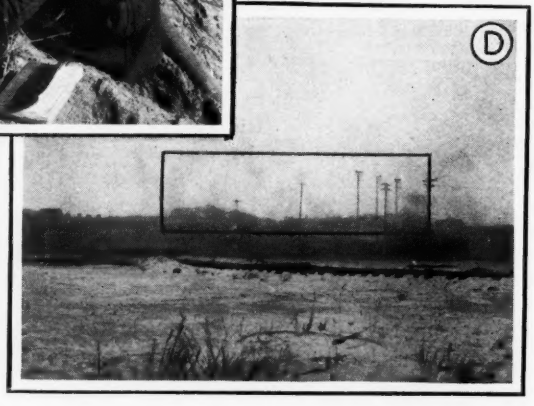
The camera may be fitted with a long-focus lens, so as to bring the smokestack that much nearer the camera, optically speaking. The entire assembly, mounted on a heavy baseboard, is covered up with a wooden box, with just a slot through which the lens is pointing. In actual use, the camera is placed at some advantageous position and set in action. It requires virtually no care, although the operator stays nearby, ready to refill the camera magazines and otherwise take care of minor details.



A. AUTOMATIC SMOKE-RECORDING CAMERA, SHOWING CAMERA PROPER WITH EXTENSION OR LONG-FOCUS LENS AND HOOD, CLOCKWORK TIMING MECHANISM, RELAY, AND CONDENSERS

B. FOCUSING THE AUTOMATIC SMOKE-RECORDING CAMERA ON A DISTANT SMOKESTACK

C. ANOTHER VIEW OF AUTOMATIC RECORDING SMOKE CAMERA, SHOWING B-BATTERIES THAT SUPPLY THE NECESSARY ACTUATING CURRENT FOR PUSH-BUTTON OPERATION OF CAMERA



D. SHOWING HOW MUCH OF THIS SCENE WOULD BE INCLUDED IN THE "FRAMES"

Proper Insulation Saves Heat Dollars*

HIGH TEMPERATURE INSULATION SHOULD BE SUCH THAT HEAT LOSS VALUE PLUS FIXED CHARGES ARE A MINIMUM. BY L. B. McMILLAN**

HIGH TEMPERATURE, or as it is sometimes called, high heat potential has a marked advantage for the development of power and often for process work, as is evidenced by the increasing use of high pressures and temperatures in the power plant. In industry in general, too, greater attention is being given to the effect of insulation in increasing production through maintenance of heat potential so that quality of product is improved, greater uniformity of temperature is maintained and the productivity of labor through better working conditions in the vicinity of heated equipment is secured.

High Temperature Heat Most Valuable

Heat conserved by insulation is the most valuable portion as it costs more to produce and does the most effective work. Power engineers do not need to be told that a given number of British thermal units at high potential will produce more power than the same number at low potential, or that maintaining the required superheat will make all heat units more effective in the turbine than if temperature is permitted to drop. There is plenty of heat in condensing water but it is useless because it lacks the required heat potential or temperature to make it capable of accomplishing useful work.

In the table are given the ratios of the value of the last increment of heat at the top of the temperature range to the value for the average of the range and it will be seen that this top increment of heat has a value between 50 and 100 per cent higher than that for the average. It is evident that the effectiveness of this last increment of heat must be greater than that of the average because the average is penalized by low effectiveness of the first increment of heat added in the cycle and the first increment of heat in the cycle can do useful work only when the high-temperature increments have been added. The values in the table are not theoretical but are intensely practical. It will be noted that the relative value of the last increment as compared with the average value decreases as pressure is increased because the average value of all heat is increased at a higher pressure. This means, not that the actual value of the high increment is less but that the value of all parts of the heat is greater. It is important to realize the dollar value of these last degrees at the top of the temperature range when applied to billions of pounds of steam handled per year.

Bare Surfaces Scatter Dollars

In the second part of the table is given the dollars loss per square foot per year from bare surfaces. As an illustration of what this may mean, in case of superheated steam pipe the per cent of surface left bare is usually quite small but, because of the higher temperatures and the greater value of the heat, the losses from such small areas may be much greater than would at first glance appear likely. For example, from one square foot of bare surface at 700 deg. F., the value of heat being 30 cents for 1,000,000 B.t.u., the loss is $9.30 per yr. If the steam pressure is 300 lb. absolute, reference to the table shows that the ratio of the high potential increment for power generating purposes is 1.54 times the average value, therefore the actual loss is $9.30 times 1.54 or $14.32 per square foot per year.

Circulation of air over the surfaces greatly increases the loss, an air velocity of 10 mi. per hr. at least doubling the loss from bare surfaces while for insulated surfaces this increase, because of the less conductivity from the insulation to the air, will be only 10 per cent.

HEAT VALUE RATIOS AND ANNUAL LOSS

	Heat Value Ratio at Various Temperatures to Average Value Steam Press., lb., abs.				Annual Loss per Sq.ft. in Dollars Steam Cost per 1,000,000 cts.				
Steam Temp. Deg.F.	40	100	300	600	20	30	40	50	60
200					0.50	0.70	0.90	1.20	1.65
300	1.22				1.10	1.70	2.15	2.70	3.30
400	1.59	1.32			1.90	2.85	3.80	4.75	5.75
500	1.86	1.44	1.28	1.18	3.05	4.50	5.85	7.50	8.90
600	2.02	1.61	1.43	1.32	4.40	6.55	8.75	11.15	13.20
700	2.14	1.82	1.54	1.42	6.20	9.20	12.40		
800	2.21	1.90	1.65	1.51	8.30	12.65			
900	2.23	1.93	1.68	1.56					
1000	2.24	1.96	1.71	1.59					

Surfaces to Be Insulated

Steam is the finished product of the boiler plant and when it leaves the superheater outlet or the boiler nozzle, if only saturated steam is produced, it is a commodity against which all costs of production have been charged. It is, therefore, desirable to deliver that product to the consumer with a minimum of loss on the way, hence pipe insulation has become a matter of primary interest, especially with increasing steam temperatures and increased cost of fuel. Thicknesses of pipe insulation are now chosen to provide adequate reduction in heat losses, yet they should not be so thick as to involve unjustified cost.

In addition to the high pressure and temperature steam mains, hot water piping, auxiliary headers, water wall circulation piping, connections from boiler nozzles to superheaters, soot blower piping, drip pipes and the like are items less important per unit of area, perhaps but, when total area is considered, they are of major importance in insulation problems. Even cold water lines must be included among the piping requiring insulation, if the troublesome drip of moisture is to be avoided.

Preheating of air for combustion is of comparatively recent development and because of the fact that heat in the air is usually recovered from what might be considered as waste heat in flue gases, it is often overlooked that this heat in the air actually does something and it is the value of the heat and not its cost that is

*From a paper before the Rochester meeting, A. S. M. E.
**Consulting Engineer, Johns-Manville Corp.

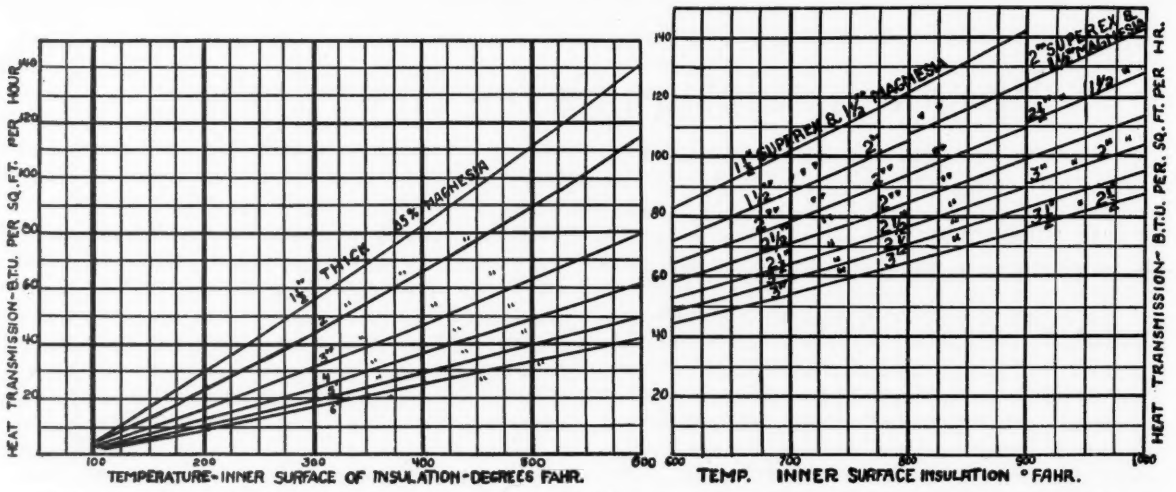

HEAT TRANSMISSION-B.T.U. PER SQ. FT. PER HOUR
TEMPERATURE-INNER SURFACE OF INSULATION-DEGREES FAHR.
85% MAGNESIA
1" THICK
1½" SUPEREX & 1½" MAGNESIA
2" SUPEREX & 1½" MAGNESIA
TEMP. INNER SURFACE INSULATION °FAHR.
HEAT TRANSMISSION-B.T.U. PER SQ. FT. PER HR.

FIG. 1. HEAT TRANSMISSION THROUGH VARIOUS THICK- NESSES OF INSULATION FOR FLAT SURFACES

important. Fixed charges on the equipment required to recover this heat must be charged against it and something over so that the major part of the cost has been expended when the equipment is put in, and that cost is incurred, whether heat is utilized after it is recovered or is allowed to escape by radiation. The value of the preheated air depends on the higher temperatures of combustion resulting from its use and the value of the preheat in the air is not less than for its equivalent in fuel. The true measure of the value of such heat is the cost of its replacement at the point of use.

Heat Loss Depends on Temperature and Insulation Thickness

Figure 1 shows the heat losses that may be expected with various thicknesses of typical insulating material and at various temperatures. Insulation practice in connection with boiler drums, heads and other exposed portions of the shell, feedwater heaters and other auxiliary equipment is so thoroughly standardized that little attention need be given it here. A notable exception is the insulation against heat losses of tube headers of water tube boilers. Perhaps these are not considered as exposed surfaces because of the doors which shut them from view but these doors offer comparatively little resistance to heat flow, and while losses from the headers are less than if the doors were omitted, they are still much greater than need be. Lining the doors with suitable insulation provides resistance to heat flow many times as great as that of the air space between the headers and the doors. Heat lost from the tube headers is at high potential and, if not lost, would be of the same usefulness as that in the saturated steam produced by the boiler.

While the curves in Fig. 1 are for flat surfaces of the boiler (not boiler settings) they will apply with reasonable accuracy to auxiliary equipment surfaces because the radii of curvature are usually quite large. If somewhat higher accuracy is required, it may be obtained by considering that the values from Fig. 1 apply to the mean area of inner and outer surfaces of the insulation, instead of to the actual area of the metal surface.

Furnace Walls Need Insulation

Insulation of boiler settings and of newer types of furnace walls are recently developed fields and in Fig. 2

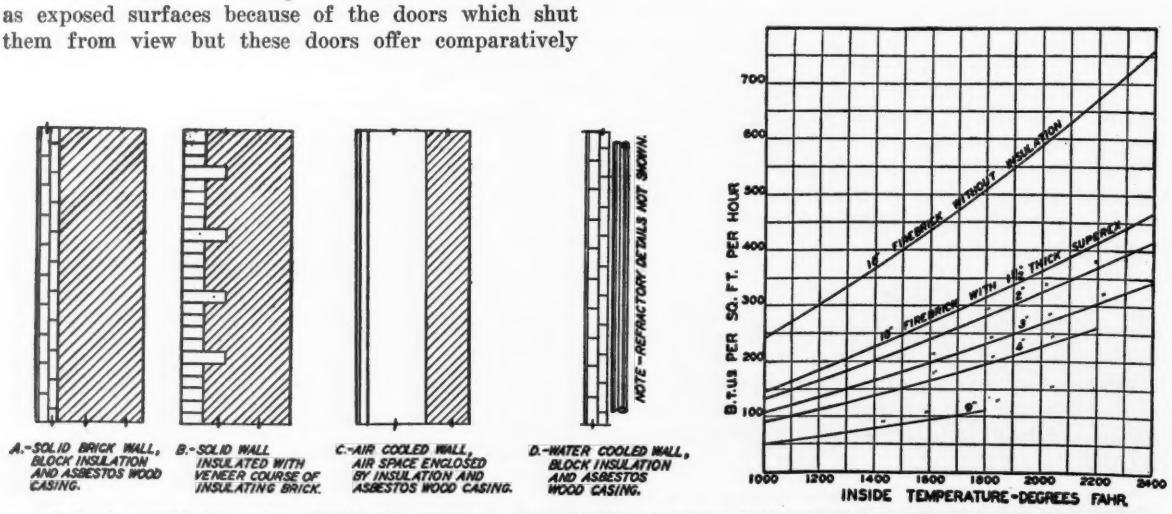

A.-SOLID BRICK WALL, BLOCK INSULATION AND ASBESTOS WOOD CASING.
B.-SOLID WALL INSULATED WITH VENEER COURSE OF INSULATING BRICK.
C.-AIR COOLED WALL, AIR SPACE ENCLOSED BY INSULATION AND ASBESTOS WOOD CASING.
D.-WATER COOLED WALL, BLOCK INSULATION AND ASBESTOS WOOD CASING.
NOTE-REFRACTORY DETAILS NOT SHOWN.
B.T.U.S PER SQ. FT. PER HOUR
INSIDE TEMPERATURE-DEGREES FAHR.
9" FIREBRICK WITHOUT INSULATION
9" FIREBRICK WITH 1½" THICK SUPEREX

FIG. 2. SECTIONS OF FURNACE WALLS AND HEAT TRANSMISSION WITH AND WITHOUT INSULATION

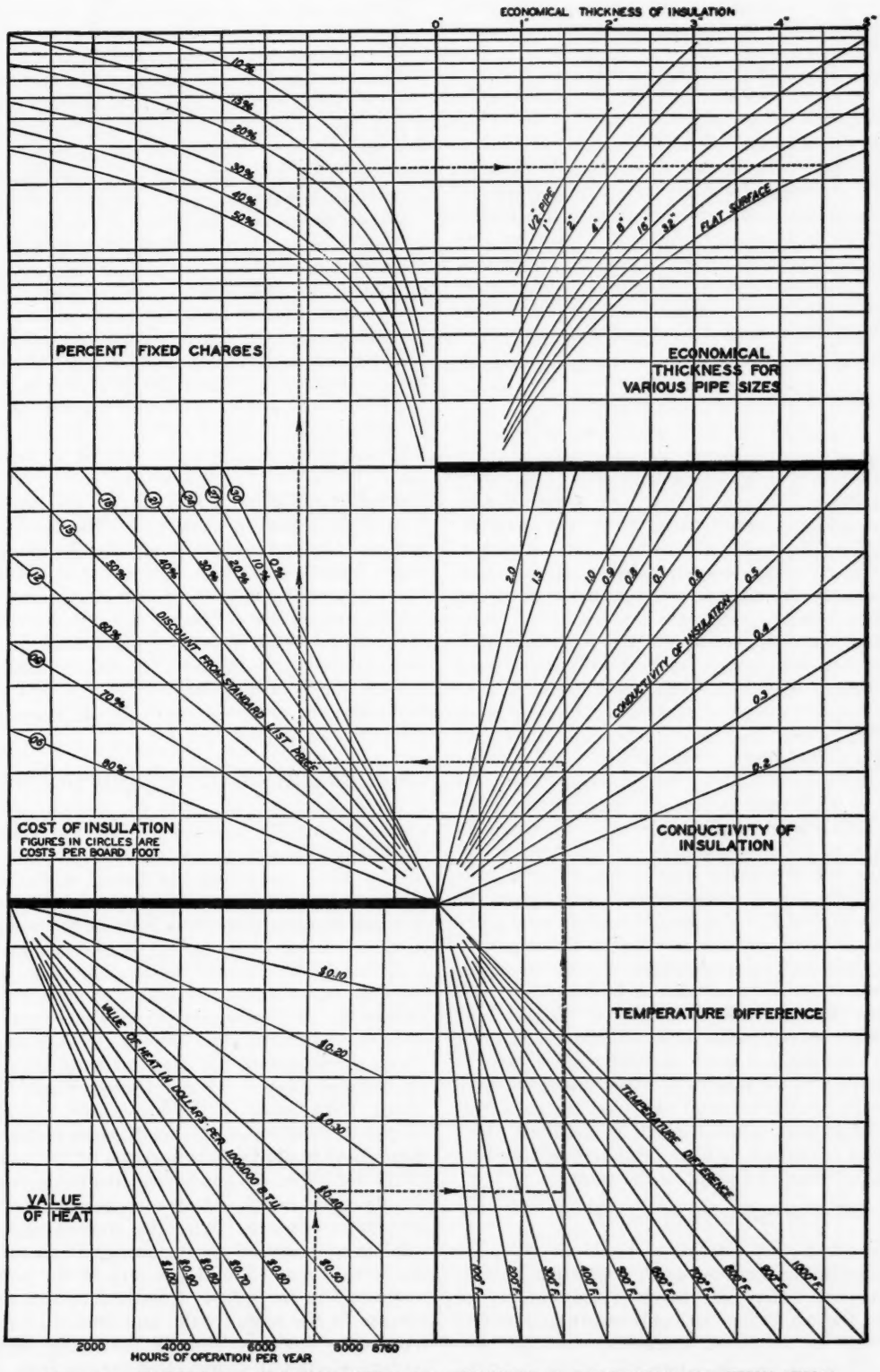


FIG. 3. GRAPHICAL DETERMINATION OF ECONOMICAL THICKNESS OF INSULATION

are shown typical sections of four modern types of furnace walls, also the values for heat transmission through insulated and uninsulated walls. The sections show no details but are simply typical of the various methods of construction. Savings represented by the differences between the curves for insulated and uninsulated walls are conservative since the conductivities of fire brick used were purposely taken at the lower rather than the high portion of the range. The values used range from 6 B.t.u. per square foot per degree temperature difference for each 1 in. thickness per hour at a mean temperature of 1000 deg. F., to 8.57 B.t.u. at 2600 deg. F. mean temperature. Many investigators have shown conductivities 25 per cent higher than these and such conductivities will result in higher losses from uninsulated walls. Losses from insulated walls would be increased somewhat by such higher conductivities but to only a small extent.

Breeching and Stack Insulation

Where insulating brick is used, the thickness is usually 4½ in. and the losses through walls insulated in this manner are closely approximated by the curves for a 4-in. thick block insulation. Air infiltration as well as heat loss may be minimized by the use of insulation but it is impossible to evaluate the saving as definitely as for the heat loss, since the extent of infiltration depends on the condition as well as the construction of the furnace wall. On both air-cooled and water walls, the savings by insulation are proportionately much greater than on solid refractory walls and a given thickness of insulation applied to either of these types will bring the total loss down to a point far below what it would be, if the same amount of insulation were applied on a solid refractory wall.

For breechings and flues, the principal reason for insulating is to prevent excessive heating of the boiler room but there is also the advantage of an improvement in draft due to lessening the temperature drop of the gases before they reach the stack. Insulation is often placed inside the breeching to provide protection of the steel against corrosion. Economizers and air preheaters, when used, give still greater advantages to the insulation of uptakes and flues, since the heat saved before reaching the economizer or air preheater has a real dollar value. In such cases, insulation of the breeching from the heat recovery apparatus to the stack, in order to prevent corrosion, is more important since there is greater tendency to condensation. Steel stacks are often provided with insulated linings to protect the steel from corrosive action and, when located in buildings, there is the further advantage that the insulation will prevent overheating of spaces adjacent to the stack.

How Much Insulation?

After deciding that insulation should be used, the question remains as to how much insulation will be most economical. Here are involved adaptability of material to the conditions of temperature and use to which it will be subjected, durability and the permanence with which the insulation will retain its initial value. These are matters for study and judgment. When these are decided, obviously the greater the thickness the lower will be the heat loss but also the greater will be fixed charges against the investment and the thickness at which the sum of these two costs, heat loss and fixed charges are minimum, will be most economical.

Figure 3 gives in graphical form the results of a method developed in an earlier paper before the A. S. M. E. for the determination of economical thickness of insulation. Factors involved are all indicated on the chart. For continuous operation, there will be 8750 hr. a year. The value of heat in dollars for one million B.t.u. will not necessarily be the average cost of heat but its value as determined from the table. The temperature difference is the temperature of the inside of the equipment insulated minus the temperature of the surrounding air. It should be noted in this connection that if there is a considerable resistance to heat flow other than that offered by the insulation, as in the case of insulation on the brick furnace walls, correction must be made for the effect of these other heat resistances. The conductivity of insulation is in B.t.u. per square foot per degree temperature difference, for one inch thickness per hour. The cost of insulation is given as a per cent discount from the standard list and also to provide for material whose costs are not figured in terms of discount the costs per square foot one inch thick are marked on the lines. Fixed charges are usually 15 per cent in the classes of work under discussion here. The method of using the chart is indicated by the dotted line, which follows through to show that for 7200 hr. operation a year with the value of heat 40 cents per 1,000,000 B.t.u., temperature difference 450 deg. F., conductivity of insulation 0.55, discount from standard list 50 per cent, fixed charges taken at 20 per cent and for a flat surface, the economical insulation would be 4½ in. thick. Of course the nearest commercial thickness is the one which should be used.

Determination of Sulphur in Flue Gases

It is well known, says the Department of Commerce, that in the burning of coal, the larger part of its sulphur content passes out with the flue gas and only a small percentage is found in the ashes and clinker. The determination of the sulphur content of flue gas involves difficulties both in the sampling and in the chemical technique. The more general practice is to sample the fuel-bed refuse, determine its sulphur content and estimate the amount going to the stack by difference. It is necessary in some investigations, however, to measure the sulphur in the flue gas directly.

An investigation has been made at the Pittsburgh Experiment Station of the United States Bureau of Mines, Department of Commerce, for Pittsburgh coal burned in the furnace of a small power boiler. Measurements were made for 8-hr. periods of the total sulphur in the refuse, in the gas beyond the bridge wall and in the flue gas, in the attempt to account for the total sulphur in the coal. With the greatest care, the total sulphur as measured always averaged less than that in the coal. From 3.2 to 4 per cent of the total sulphur was found in the refuse; from 82.2 to 93.3 per cent in the gas at the bridge wall; and from 75.4 to 83.4 per cent in the flue gas. Thus, at the bridge wall, the percentage of sulphur unaccounted for ran from 3.5 to 13.8 per cent, while in the stack there was missing from 12.6 to 21.4 per cent. Investigation showed that great care must be taken in the sampling and in the analytical technique or the sulphur so measured may be too low.

Forge Equipment for Restricted Areas

AROUND OUR SHOP there are several places where a forge for heating material is needed. As the room at such places is much restricted, we hit upon the following procedure and incidently also avoided buying several small motors and blowers. Compressed air lines carrying 100 lb. press. run all over the factory and at no place was more than 20 ft. of ¼-in. pipe needed to connect the air line to the mixing head.

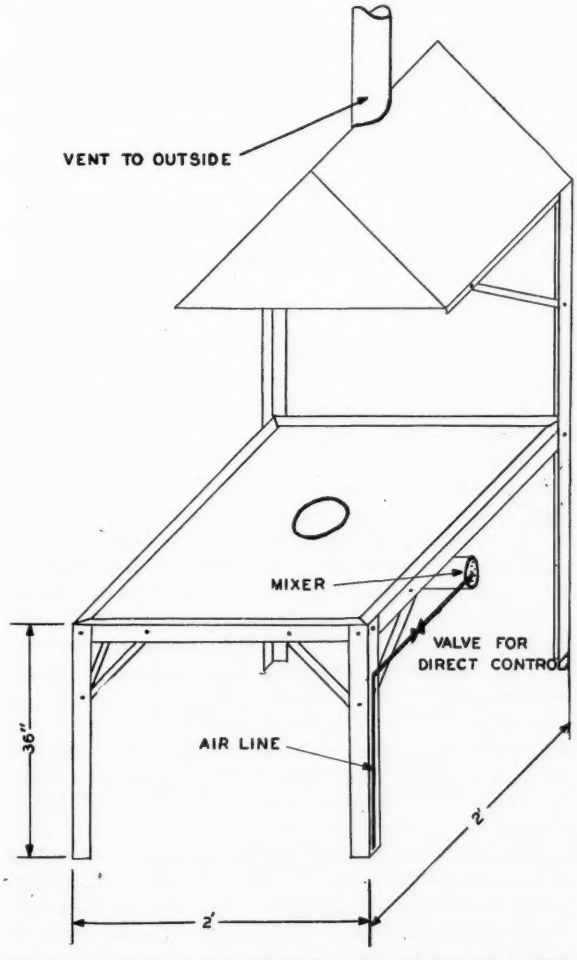


FIG. 1. FORGE CONSTRUCTED OF ANGLE IRON AND SALVAGED PARTS SERVES WELL IN SMALL SPACE

Forges were constructed as shown in Fig. 1. The frame was made of 1¼ by 1¼ by ⅛-in. angle iron, the braces of ¾ by ¾ by ⅛-in. angles covered with galvanized sheet iron. The vent connected to the hood was old 10-in. blower spouting, salvaged from scrap. The top or table for the fire box was made of some old ¼-in. steel plate that came from an old steel floor. The

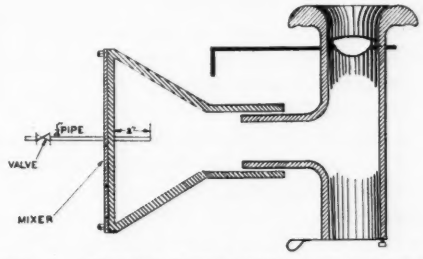


FIG. 2. TUYERE WITH MIXER ATTACHED

tuyere was set about 1 in. higher than the plate on which was put a bed of sand. As shown in Fig. 3, the plate is 5 in. diameter, with six ¾-in. holes drilled in it. The centers of these holes are laid out on a 3-in. circle and a hole drilled and tapped in the center for ¼-in. pipe. Around the edge, four holes were drilled for No. 12-24 machine screws which fasten the plate to the part that slips over the tuyere connection.

In operation, the air is turned on the ¼-in. pipe which projects 2 in. through the mixer-plate. This draws air in through the ¾-in. holes and creates a good blast. In fact, after a fire is started the ¼-in. valve

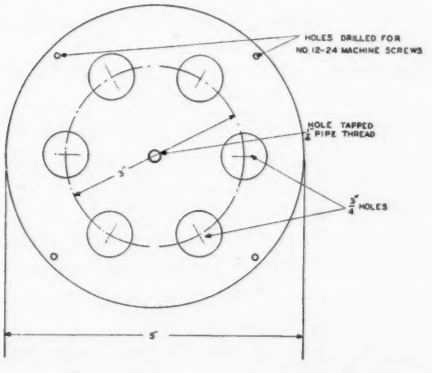


FIG. 3. MIXER PLATE SHOWING HOW HOLES WERE DRILLED FOR DRAFT

is hardly ever opened more than a half turn of the valve stem as you can blow the fire out of the forge, if you give it too much draft. In our case, the air line comes up through the floor and up one of the legs, which locates the air valve in a handy place for the operator. Thin plates of sheet iron are put on the sides to keep sparks from flying out and the back is closed with sheet iron. The side plates are attached so that they can be taken off easily in case a long piece is to be heated. In one of these forges, we have successfully heated pieces 2½ in. diameter and 10 ft. long that had to be hot for almost their entire length.

Minneapolis, Minn. FRED S. RUTLEDGE.

Meeting an Emergency

IN THIS AGE of efficiency and specialized effort, almost anything seems possible. The real test comes, of course, in an emergency. In this Connecticut town, the water is supplied from a pumping station which is owned and operated by the Northern Connecticut Power Co., which supplies water, power and electricity to several towns in this vicinity.

During a severe thunder storm, the pumping station was struck by lightning, which started a fire that consumed the building and seemed to have damaged the pumps and motors beyond repair. While the fire was still burning, preparations were made for assuring the town a continuous water supply. At once, word was sent to officials of the power company and a consultation was held at the scene of the fire. In a few hours, the water superintendent had work under way to establish a cross connection with the pipes of the Springfield, Mass., water supply. In spite of the fact that this work had to be done under handicap of darkness, by 4 o'clock of the following morning, water was flowing through the cross connection and our town was assured of a continuous water supply until the damage to the pumping station could be put in order.

But the power company did not let up with this effort. Hardly waiting for the ruins to cool, the superintendent of construction had the debris cleared away from the pumps, when it was found that the big pump, with a few repairs, could be placed in operation, driven by an electric motor. A big motor of a size not carried in stock, would be required for the purpose. But numerous telephone calls finally located one of the right type. It was rushed here as quickly as possible, placed in position and connected, a temporary housing erected to protect it from the weather and in less than 48 hr. after the damage to the plant, the big pump was again operating normally.

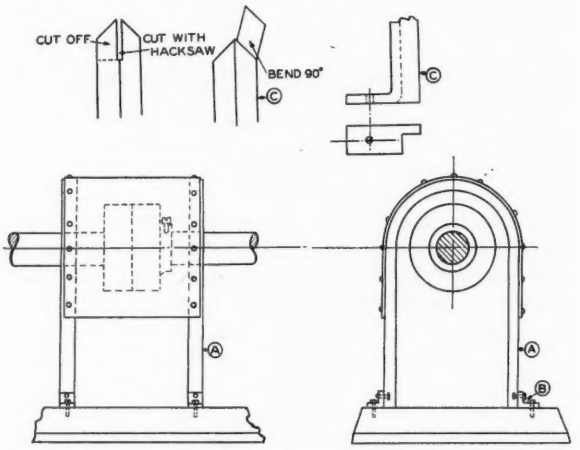
Suffield, Conn. F. W. RICH.

Simple Guard for Pump Shaft

Many small couplings such as used on centrifugal pumps are left unguarded and are a source of danger to men working about them because, although they have few projections to catch clothes on, those projections are dangerous and centrifugal pumps often run so smoothly that it is difficult to tell whether the pump is running or not so that men become careless.

Guards can be easily and cheaply made from small angles and light sheet iron as shown in the sketch. In finding the proper length of angle iron to cut, the easiest way is to take a piece of wire and bend it from the bedplate over the coupling in the shape desired; then straighten out this wire and measure it. Angles for both sides should be cut the same length and bent to the same radius, allowing about two inches clearance between the coupling and guard.

After the angles are bent, the sheet iron cover should be cut and fastened to the angles by bolts or, preferably, by small rivets. When this is completed, the guard can be fastened to the bedplate by small angles as shown at B or the angle itself can be used for this purpose by cutting a slot three or four inches down the angle, sawing one side off and bending the other one over 90



ANGLE IRON AND SHEET METAL FORM EFFECTIVE GUARD FOR THE PROTECTION OF ROTATING SHAFT

degrees to form a foot as shown at C. The simplest way of fastening this guard to the bedplate is to drill and tap the bedplate and use cap screws to hold it down.

Brooklyn, N. Y. P. F. ROGERS.

Boiler Blowdown Precautions

FAULTY OPERATION or faulty installation of boiler blowdown cocks and pipes has been the cause of serious accidents. Where a number of boilers are in a bank, the blowdown on a working boiler should never be opened unless the blowdowns of all dead boilers are closed. If a boiler is blown down while the blowdown of a boiler under repair is open, the steam and scalding water from the blowdown may enter the dead boiler in such quantities as to scald anyone inside of the boiler.

When opening the blowdown of a boiler, the cock should be opened full. If it is only half open, the rushing water and steam will scour the plug surface and in time cause the valve to leak. Ashes should never be allowed to collect around the blowdown pipe, as this will cause serious corrosion. The plug of the blowdown cock should be withdrawn yearly to see whether it is steam tight and, if found to be worn, it should be ground in or replaced.

The discharge end of the blowdown pipe should be kept under observation for steam leakage. If leakage shows here, it is an indication of a defective valve.

All connections of the blowdown pipe should be as flexible as possible so as to allow the pipe to follow the movements of the boiler as it expands and contracts

and also to permit its own expansion during the blow-down period. Serious accidents have occurred through pipes fracturing, owing to their being held rigidly in brickwork, or because the connections were too rigid.

Brentford, England. W. E. WARNER.

Bending a Cast-Iron Pipe

DURING THE overhauling of a rather antiquated and isolated steam plant, it became necessary to bolt together the flanges of two lengths of 6-in. pipe which could not be made to face each other squarely. In fact, the 10-in. dia. flanges were open a half-inch on one side, while touching each other on their opposite edges. A taper flange had been used, therefore, to make the connection, one edge of this tapered flange being a half-inch thicker than the other. The engineer claimed that there was always more or less trouble from leakage at these joints and it was decided to get rid of the loose tapered flange if possible.

The 5-ft. length of the 6-in. pipe, to which one of the flanges was attached, was placed on the ground, alongside of a railroad siding, on three piles consisting of two bricks each. The brick piles were leveled so that the pipe laid fair upon each of them. The ends of the pipe were then chained to the rail in such a manner that the pipe lay level with and parallel to the rail and about 5 ft. from it. A jack-screw was placed horizontally upon the ground, levelled and its bottom end blocked fair against the flange of the track rail. A piece of old 2-in. pipe was cut long enough to reach between the jack screw and the middle of the cast-iron pipe and its end, which bore against the 6-in. pipe, was notched slightly with a hacksaw until it had a good bearing against the cast-iron pipe and would not slip.

With the jack and 2-in. pipe in position and the jack screw tightened to bring a strain upon the pipe, a wood fire was built around the middle of the pipe and the jack screw tightened as the cast-iron pipe became heated. After the pipe had been bent 1½ in., it was allowed to cool and it was found that the flanges now faced each other fairly.

Indianapolis, Ind. JAMES F. HOBART.

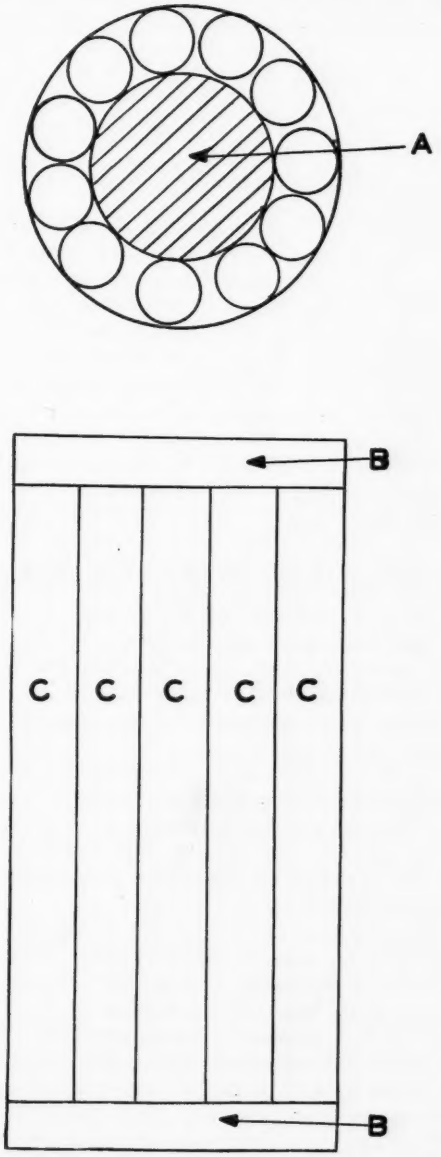
Packing a Scored Piston Rod

SO LONG AS a piston rod is properly lubricated and packed, it will not score. Since, however, poor quality oil and packing are sold and careless or inexperienced men are employed who use them, there will be scored rods.

An engineer who accepted an offer to take charge of a new plant, found that his predecessor had left him, among other undesirable things, a badly scored piston rod. Conditions were such that he was unable to have the rod repaired or replaced with a new one as should have been done. The rod was so badly scored that new packing placed into the box around the rod in the usual way would be cut to pieces by the grooves in the rod in a short time. In such a case, even with good packing, continually tightening the box would stop the leak only temporarily and this tight condition so increased the friction on the rod that it not only hastened the destruction of the packing but also increased the scoring action on the rod.

As an experiment, the engineer tried a suggestion which, although far from being a perfect solution of his problem, was at least an improvement over the method used before.

Instead of placing the packing in a number of rings around the rod A, he cut only two rings, one for the top, the other for the bottom of the box as shown at B in the illustration. After setting the one ring in the



PACKING PLACED PARALLEL WITH THE PISTON ROD WEARS BETTER THAN WHEN PLACED IN RINGS AROUND IT

bottom of the box, straight pieces of the packing were cut and set in the box on top of the ring. These pieces were placed parallel to the rod as shown at C. The other ring was then placed on top and the box tightened up.

With the packing set into the box in this way, it seems to last longer than when placed in rings around the scored shaft. Why it should do so seems difficult to understand. Nevertheless this is a fact.

Uffington, Ont., Can. JAMES E. NOBLE.

Cleanliness in the Boiler Room

SOME MONTHS AGO, an article was published in the letters department on cleanliness in the engine room. I feel that the boiler room also should be included in such a discussion.

A few weeks ago, I visited the power house of one of the largest automobile plants and I must say it was one of the most poorly kept places I ever have seen. Old pipes, old shovels and a miscellaneous lot of old junk that should have been sent to the scrap yard years ago were scattered about the boiler room and from the appearance of the room, it had not been swept in many days. The light was poor and there was no evidence that the place had been painted. The equipment itself seemed to be good but the condition in which it was kept was deplorable.

Then I inspected the engine room, expecting to find conditions better there but no man with a bit of pride as an engineer would have tolerated the condition I found. The turbines appeared as if they had been in a fire. Grease and dirt were burned on them and here and there a bit of aluminum paint showed through.

There seems to be a woeful need of training relative to housekeeping among operating engineers. Manufacturing managers seem to lack interest in their power plants. I believe this to show a wrong attitude and poor judgment on the part of such management.

Detroit, Mich. B. E. WHITLOCK.

Coating Belts Eliminates Static Electricity

INTERESTING and valuable advice on the elimination of static electricity from power transmission belts is given by P. W. Edwards and J. O. Reed of the Bureau of Chemistry and Soils of the U. S. Department of Agriculture.

They find that the best way to eliminate belt static is to apply a material which will serve as a good conductor of electricity to the surface of the belt. Such a method is perfectly logical and there is nothing new about it but the question has always been, what is the best material to use?

We all know that rapidly moving metal parts such as metal disks, never cause static troubles. Why? Because the disks themselves are excellent conductors of electricity. Metal band saws which run at velocities of thousands of feet per minute never have static troubles because metal saws conduct electricity. Good sense, therefore, tells us that, if any belt can be converted into a perfect conductor of electricity, there will be no static whatever and practice proves this theory to be correct.

Material applied to a belt for the removal of static must not, however, decrease the coefficient of friction between the belt and the pulleys; it must not injure the belt in any way and it must wear well.

Edwards and Reed experimented with a number of materials for use on rubber belts. They found that "a good grade of spar varnish was a satisfactory vehicle." Powdered aluminum, bronze, copper, graphite, and lamp black were tried as conducting mediums and various proportions of each of these materials were mixed with spar varnish.

The most satisfactory result for a non-static rubber belt dressing was obtained by using 18 parts of lamp black with 82 parts of good spar varnish. For a good non-flammable thinner, they recommend equal volumes of carbon tetrachloride and Varnish Makers and Painters naphtha. This was carefully tested on belts in actual installations on an air compressor and on a rubber conveyor belt and also on rubber belts in flour mills and on threshing machines. They write: "No trace of static was detected after the dressing had been applied." The belt should not be used until the anti-static dressing has thoroughly dried.

While this material is all right for rubber belts, it is not satisfactory for leather belts. They recommend for the latter the following formula:

100 cc. liquid fish glue, 88 cc. glycerine, 100 cc. suphonated castor oil, 170 cc. water, 82 grams lamp black, 20 cc. of two per cent ammonium hydroxide.

They state that in some instances it might be well to increase the quantity of glycerine and fish glue. The material for leather belting may be applied while the belt is moving and in use but the dressing for the rubber belting must be allowed to dry before the belt can be used.

Newark, N. J. W. F. SCHAPHORST.

Correction of Engine Parts Forestalls Trouble

WHEN A STEAM engine has seen considerable service, trouble is liable to occur at the connection of the valve rod and the eccentric rod. If wear occurs to such an extent as to permit play between the two rods, the timing of the valve will be altered.

In one instance, a severe knock was continually occurring in the high-pressure cylinder of a locomobile engine. The cause of this knock was eventually traced to play in this connection which had altered the timing to such an extent that there was practically no cushioning at one end of the cylinder, hence a severe knock occurred as the piston passed the dead centers. After this wear was taken up and the timing was readjusted, the knock disappeared. The best precaution against this wear is to keep these joints well lubricated.

In another case, a uniflow engine broke down through the piston seizing because of faulty cylinder lubrication. The cylinder lubricators were discovered to be out of order and delivering an insufficient amount of oil. In addition to this, the original cast-iron piston had been replaced by one of steel casting. Steel pistons are unsuitable for use in horizontal engines and this piston aggravated the lubrication trouble.

Efficient lubrication of uniflow engines is important; an oil should be used that is capable of fully standing the cylinder temperature and sufficient lubrication should be used to insure distribution of the lubricant throughout the cylinder. Occasionally, the piston rods should be removed from their crossheads for examination, as it is not unusual to find cracks developing around the cotter pin holes.

Brentford, England. W. E. WARNER.

NEW ORDERS for 1749 steel boilers were placed in May, as reported to the Department of Commerce by 80 manufacturers, as compared with 1706 boilers in April and 1836 in May, 1928.

Questions and Answers

Identification of Old Corliss Engine Desired

I am operating an old Corliss steam engine whose nameplate is missing. Data concerning the engine are:

Size 14 by 32 in., 85 hp.
Interchangeable from right to left.
Wood lagging on cylinder.
V-shaped guide.
Porter's governor head.
Bearing on both ends of valve stems.
Single eccentric.
Frame or bed bolted to main bearing.

Certain repairs are necessary and I am anxious to find out the manufacturer's name. I shall be obliged if you can help me out. R. F. M.

Editor's Note: We would appreciate hearing from any reader who may be able to throw light on the identification of this engine.

Construction of Transformer Type Battery Charger

CAN YOU LET ME know how to construct a transformer-type battery charger for one to 20 batteries of 6 v. each, to be used on a 110-v., 60-cycle, a.c. line using the General Electric 6-amp. bulb? G. C.

A. We are giving below the specifications for a charger which will use the regular General Electric, 5-amp., Tungar bulb but we do not believe that you would be able to charge more than 10 or 12 6-v. batteries with it at any one time.

Considering a 6-amp. charging rate, as you suggest, would leave you about 1/3 amp. for each battery if 20 were being charged at one time. One-third ampere would be sufficient to keep a battery charged on trickle charge but you would not be able to bring up a run-down battery with this low-current rate. The transformer used in this charger is built up from pieces of soft black iron or silicon steel of about No. 28 gage, each piece measuring 1 7/16 by 4 3/16 in. A stack of these pieces 5¾ in. high will be required for the complete core. The core, when assembled in the usual fashion, will be 1 7/16 in. sq. in cross section and will have a window 2¾ in. sq.

For the primary winding, 550 turns of No. 18 double cotton covered wire will be required. The secondary winding consists of 135 turns of No. 14 or preferably No. 12 double cotton covered wire. The winding is tapped at the 100th, 105th and 135th turns to provide for a variation in the charging current.

The filament heating winding in the case of the 5-amp. tube must carry about 8 amp. and, if it is tapped in the center which is advisable, it must also carry the charging current, making a total current of 13 amp. Two No. 10 or No. 12 double cotton covered or enameled wires in parallel may be used for this winding. Ten turns of this double wire will be required with a tap brought off at the center of the winding. Be careful when bringing off this tap or in making other connections in this filament circuit to see that the connection is sturdy enough to carry the current without heating.

After the windings are found, they must be taped with either black friction tape or Empire cloth to prevent damage to the insulation in slipping them on the core. When the windings have been placed on the core, it is clamped together by pieces of 1 by ⅛-in. angle iron with ¼-in. bolts. If you are unable to get the pieces of angle iron, four pieces of hard wood 1 in. square will suffice. The transformer is mounted by placing it on two blocks of wood 1 7/16 in. square and 5⅝ in. long and clamping it down to the wooden base by two strips of sheet iron. The Mogul socket for the rectifier bulb is mounted directly behind the transformer. A piece of bakelite or ebony asbestos board 8 by 9 in. and ¼ in. thick and 3 wood screws hold it to the wooden base. After everything is mounted on the panel, connections should be done as in the diagram.

A few words on the operation of this charger may be of help to you. When charging, a blue haze should show around the filament in the tube and the transformer will hum slightly. If the filament lights but no current goes into the battery, try turning the 110-v. current on and off rapidly several times in succession. If it still does not start charging, it will be necessary to put a few more turns (about 10) on the charging winding. Perhaps the rectifier will go the limit in the other direction and charge at an excessive rate and the plate of the rectified tube will become bright red. In this case a few turns should be removed from the charging winding to lower the voltage as when in normal operating condition the plate should never exceed a very dull red.

Aside from this it would be well to check the filament voltage with an a.c. voltmeter. This should be between 2 and 2.25 volts. If one of the transformer coils gets very hot, there is liable to be a short-circuited turn in the coil, in which case the coil should be rewound.

High Stack Temperature Causes

WHAT ARE THE causes of high stack temperatures? J.W. B.

A. Among the causes of high stack temperature are: poor combustion, insufficient air above grates, high percentage of volatile in coal, sooty or scaled tubes, poor baffling, broken baffling, improper furnace proportions, inefficient heating surface and poor water circulation.

Editorial Comment

The Engineer's Larger Opportunities

Engineers, whether designers or operatives, are men and citizens. While they deal with facts and materials, because their occupation is devoted to relieving mankind of drudgery and hard labor and to increasing its material welfare and its comforts, engineers should be altruistic as to the mental and spiritual progress of humanity. Their opportunity and their duty were so well considered by President R. F. Schuchardt, of the American Institute of Electrical Engineers, in his address before the annual meeting, that it is worth while to quote him at length.

"Are we of the engineering kinship, who are presumably well trained to determine facts and to reason from them, giving sufficient thought to the morrow?

If it is true, as Professor East has written, that man stands today at the parting of the ways, with the choice of controlling his own destiny or of being tossed about by the blind forces of his environment, then it will be well for the engineer to concern himself more with the environment. He should take a larger part in the leadership seeking solution for the human problems that vitally influence the trends. Earlier civilizations existed on relatively small areas. Today the entire world is a neighborhood—made so largely by the work of the engineer. Not only is it a neighborhood world but also a much more densely populated world and the great increase in population, we are told, started with the industrial revolution in the eighteenth century—also based on the engineer's work. The engineer, responsible for so much that is, cannot shirk his responsibility for correct guidance of what shall be.

Our civilization has come to be known as the Machine Age and as such it is both lauded and condemned. President Glenn Frank in a splendidly balanced analysis of the machine age and its trends, offers this comment:

'. . . the masses have more to hope for from great engineers, great inventors and great captains of industry than from the social reformers who woo them with their panaceas. The greatest social progress of the next fifty years is likely to come as a by-product of technical progress.'

With this encouragement, let us see if as engineers we have not an exceptional opportunity to gain in our individual lives that true satisfaction which comes from an attempt to leave the world a better place than we found it. The engineers, besides 'directing the powers of nature for the service of man,' now finds himself occupied at times in social guidance so that the tools he has provided shall be properly used.

The engineer's machinery makes it possible to provide the necessary food with the expenditure of less manpower than formerly and his transportation developments readily bring the food to the urban population. But with rapidly increasing population the problem becomes more and more difficult.

Professor East cites figures to prove that the maximum food supply that can be produced on the land area of this globe available for that purpose will support a population of fifty-two hundred millions, a figure which at the present rate of increase, he says, will be reached in about a century.

We are not directly concerned with the exact decade when world saturation will be reached but we are vitally concerned with the provisions for living and for advancing civilization while man's neighbors are crowding closer and closer. The marvels of science have lulled the layman into a false sense of security. No engineer worthy of the name can take a laissez-faire attitude on problems that deeply affect human welfare and progress.

How does the engineer picture the future city? Is it to be a mechanical Colossus full of ingenious provisions for commerce and industry, for housing and for getting about, or will it be a place where man still has some contact with nature? Are we building the City and forgetting the Man, as Grosvenor Atterbury suggests, and are we not fast losing our sense of values? Can a life develop properly when shuttling in crowded cars, through crowded streets or supercrowded subways, between an office which sees the sun for twenty or forty minutes a day and an apartment home in a high building closely touching elbows with neighboring high buildings?

Our physical surroundings, things we can change if we will, offer a fertile field for the interest of engineers with their vision and with their desire for lifting life to higher levels."

As conditions which need the engineers' help in alleviation, Mr. Schuchardt spoke of the poisonous exhaust gases from automobiles, air pollution from chimney smoke and gases, nerve-racking noises, neglected back yards and surroundings of dwellings, and development of cities according to proper plans.

"The increasing population, Professor East says, requires that each year forty million acres more must be tilled and harvested than the year before to provide sufficient food, and this clearly makes countries more and more dependent on one another and at times will shift the direction of the dependence. The engineer has brought countries together by rapid transportation. What can he do to hold them together as friendly neighbors?

The material work of the engineer deals with nature's laws. He knows he must understand these laws and must use truth in his work or it will fail. Engineering analysis applied to human relations similarly seeks to find the underlying laws. A study of past civilizations indicates that they failed because of violation of the basic social law which bids us do unto others as we would have them do unto us. Is it too idealistic to expect improvement in our day to come as a result of engineering method applied to the solution of ques-

tions that tend to bring discord between peoples and between people? There is encouragement in the statement made by Bertrand Russell, 'I look, therefore, to the western nations, and more particularly to America, to establish first that more humane, more stable and more truly scientific civilization toward which, as I hope, the world is tending.'

But here is a bit of pessimism.—The high speed at which life seems to be driven today and the apparent immersion of large numbers in gross materialism has filled some people with fear and misgivings regarding the future.

Even our own Lorado Taft, with a fine enthusiasm for beauty and an outstanding genius for creating it, is led by his observation to conclude that Americans are practically immune to the arts, have no joy in creating, and are not interested in the most important thing of all, the creating of an ideal civilization. He fails apparently to see the poetry in the work of a Millikan, a Langmuir, a Steinmetz, or an Edison. He should see, as Pupin and others so clearly see, the idealism of the American machine.

The engineer with his enthusiasm over the human purpose of technology's accomplishments is guided by his ideal of a better living for man but he keeps his feet on the ground in a practical effort to reach this goal step by step.

Is not one true indication of the direction in which we are moving found in the growing appreciation of beauty? The advertising pages of our magazines clearly show the turn of the tide. On every hand commercial competition seems to be along lines of greatest devotion to a beautiful product, and this is not confined to automobiles and bathroom fixtures.

The engineer accepts the line from Keat's famous Ode

'Beauty is truth, truth beauty.'

He is conscious of the beauty and the romance in many of the facts he deals with but he does not let his enthusiasm over the beauty, or his dreaming stirred by the romance,blind him to a proper weighing of the facts. Rather he develops from his dreaming a use of the facts for the further enrichment of life.

Our Institute carries inspiration to its members to be not only technicians of high order but also trained seekers of the needs of mankind, applying their skill and their knowledge to the end that life for the teeming millions of their fellowmen may be made more worth while, less burdensome, more healthful and more noble."

Dust Determination of Filtered Air

Because of the increasing importance of air filtering and conditioning in industries, the need of a method of determining the quantity of dust in the air is assuming increased importance. Such a method, to be acceptable, must be simple, rugged, within the reach of the average engineer and should not require trained operators in order to obtain consistent readings.

Obviously the results obtained do not have to be absolute but the relative results must be consistent and of such a type that they can be used for all industries. One of the important factors to be determined is the limiting size of the particles which are to be considered. Another point, especially with apparatus which uses but a small proportion of the total air flow for determinations, concerns the qualities of the sample extracted, that is, is the proportion of dust consistent and uniform for the air samples obtained. A third point concerns the proportion of dust actually removed from the air.

In this connection, the work being carried on at the University of Minnesota is of major importance. So far, two types of test apparatus have been thoroughly investigated and their advantages, disadvantages and limitations determined. When completed, these impartial tests will automatically eliminate some devices and we hope will show some single piece of equipment to be of such merit that it will be accepted generally by all industries as a standard and uniform basis of comparing air filters and air conditioning equipment.

Power and Our Industrial Prosperity

In spite of unconfirmed rumors that the end of the present wave of prosperity is in sight, findings of the National Industrial Conference Board indicate that the generally prosperous condition of the country is not only being maintained but is actually on the up grade.

Industrial and trade activity, indeed, seems "on the road toward establishing a new high second quarter record. The iron and steel industry during May established new high daily, monthly and five month records in the output of pig iron and steel ingots, and the first half of June discloses no appreciable abatement of this rate of production. The demand for steel from manufacturers of agricultural implements continues in large volume. Miscellaneous industries, such as radio and refrigerating manufacturers, are making up the decline in demand by automobile manufacturers.

Employment and payrolls increased during May and for the first time since the Bureau of Labor Statistics has been reporting on employment it has been greater in May than in April. Employment in May was 6.7 per cent higher than in the corresponding month a year ago and total payrolls 11.4 per cent higher. The generally expected, more than seasonal decline has not materialized; on the contrary, unfilled orders, back-logs and stocks on hand indicate conditions much better than anticipated.

Through the entire report reviewing conditions in various industries such as the automobile, rubber, petroleum, iron and steel building construction, textiles, mining and agriculture, the importance of power and power utilization is apparent.

It is only through the increased use of power that industry is able to increase the output with constantly decreasing unit costs in spite of the sharp rise in the cost of raw or unfinished products.

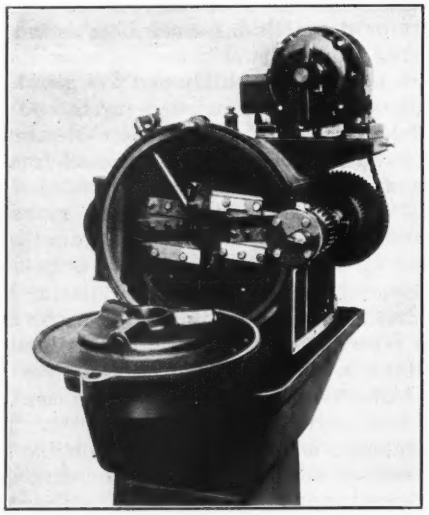
One machine using a few kilowatts will take the place of perhaps a dozen men. Contrary to fears in some quarters, this has not resulted in the accumulation of surplus labor nor has it added appreciably to the unemployment problem. Utilization of automatic and semi-automatic machinery has rendered industry as a whole comparatively independent of skilled labor and made easy the transfer of labor.

As yet, the important part that power has played in the industrial development of our country is hardly appreciated because it is overshadowed by the machines and organizations designed to utilize and take advantage of this power but, in the future when the situation is viewed from a distance, it will be impossible to overlook the important part that abundant power has played and is now playing in the prosperity of our country.

Power Plant Engineering Developments and News

Revolving Head, Blade Type Cutting-Off Machine

FOR CUTTING bar stock and pipe, a new revolving head blade type cutting-off machine has recently been announced. Advantages of the revolving



CUTTING-OFF MACHINE FOR BAR STOCK AND PIPE, CAPACITY ¼ IN. TO 2 IN.

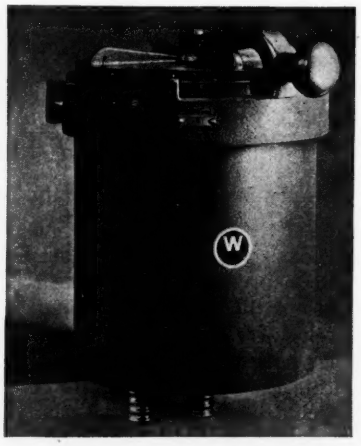
head type machine are claimed to be minimum weight, power and floor space, and the absence of severe whipping of stock that is not absolutely straight. Capacity of the machine is ⅜ to 2-in. solid stock and ¼ to 1½-in. pipe or tubing. The machine is powered with a universal motor operating from a light socket or permanent wiring installation and operates on 110 v., single phase, of any cycles, 25 to 60, or 110 v. d.c. The chief reason for this type of motor is that its speed is governed by the load put on the machine, therefore the spindle speed increases inversely with the diameter of the stock throughout the entire operation.

Motor drive is through a silent chain to a jackshaft mounted in Timken roller bearings. The jackshaft carries the speed clutches and drives the spindle, which is also mounted, both front and rear, in Timken roller bearings of liberal size.

The machine, a product of the Oster Manufacturing Co., Cleveland, Ohio, carries all of the necessary accessories such as cutting compound pump and reservoir, chip strainer, guard, and is delivered all ready to attach to any 110-v. line.

Controller for Small Motors

ADDING to its line of explosion-tested type motors and controllers, the Westinghouse Electric & Manufacturing Co., East Pittsburgh, Pa., announces a new controller of the drum type designed to provide across-the-line starting for a small d.c. motor. The controller is provided with fuses mounted inside the controller case and interlocked with a screw type cover to meet the requirements of the U. S. Bureau of Mines for explosion-tested equipment. Accessibility is one of the features of this small controller, provided for by mounting the entire controller on the bottom base. The bottom base is threaded to screw into a cylindrical case. Removing this case uncovers the entire controller for inspection



SCREW TYPE COVER IS INTERLOCKED WITH FUSES ON NEW CONTROLLER

or maintenance. The controller is designed as a small compact unit for application on permissible type conveyors, pit car loaders, room hoists, small pumps and similar types of apparatus where explosion-tested equipment is required.

Coal Protectors for Coal Storage Piles

TO PROVIDE a suitable method for detecting dangerous temperatures in stored coal, the Coal Storage Protector System shown here has recently been developed. This system employs two indicating devices. The first is the Sentinel type coal-protector, a number of which are installed permanently in the stored coal, in the manner shown in Fig. 1. This device consists of

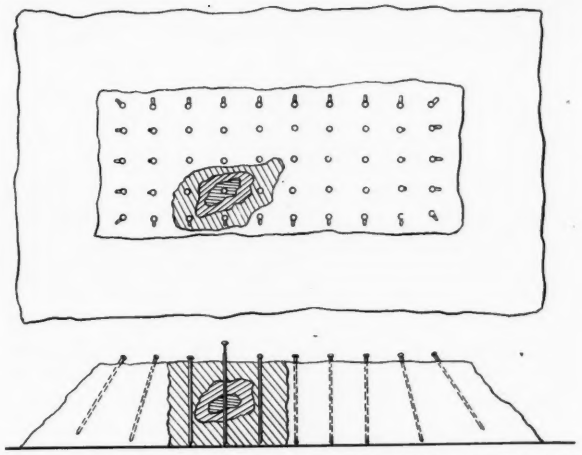


FIG. 1. SENTINEL TYPE COAL-PROTECTORS INSTALLED PERMANENTLY IN PILE, WITH HOT SPOT SHOWN BY BLOWN SIGNAL

a special acid-resisting steel tube, containing a spring-loaded plunger held down by a chain of chemical fusible links, about 2 ft. apart in the tube, each link insulated from the others. These links fuse at the critical or dangerous temperature of the coal, 150 deg. F. and if the coal surrounding the tube reaches this temperature, a link will fuse and release the plunger, which springs out of the tube 10 in., giving a visible warning.

When such a warning is seen, the second device, the Indicator type coal-protector, may be used to determine by exploration or "probing" the exact extent and temperature of the heated portion. This instrument consists of three sensitive thermometric elements in an acid-resisting tube, the three elements being located at different levels in the tube say 2 ft., 8 ft. and 13 ft. from its tip and each one being connected to a direct-reading dial type thermometer, calibrated in degrees Fahrenheit, with the warning and absolute danger zones emphasized by green and red background. With this indicator, the operator probes around the spot marked by the warning sentinel, to determine the extent of the heating, determining the temperature at three levels with one insertion.

After determining exactly where the hot coal is, the operator can then remove it and dispose of it in a suitable manner, without the necessity of moving more of the pile than is heated. Both Sentinel and Indicator type coal-protectors are equipped with fluted bronze points, to make it easy for one man to push them into the coal. Figure 2 shows how these devices are used. They are made by Coal Specialties Co., 50 Church St., New York, N. Y.

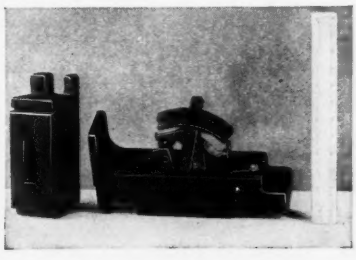
FIG. 2. USE OF INDICATOR TYPE COAL-PROTECTORS TO SHOW EXTENT AND TEMPERATURE OF HEATED AREA

Deion Circuit Breaker of 15-Amp. Capacity

FOLLOWING the announcement of the Deion circuit breaker principle, the Westinghouse Electric and Manufacturing Co. has placed on the market a new 15-amp. breaker based on this principle. This device is intended to replace the conventional panelboard toggle switch and fuse and to eliminate the cost and trouble of fuse replacements because, when an abnormal overload occurs on a branch circuit, the breaker opens automatically, it is stated, and can be immediately reclosed, provided the overload condition is not sustained. The automatic mechanism trips free from the handle so that the contacts cannot be held closed against an abnormal overload or short-circuit.

This circuit breaker consists of a rugged toggle mechanism to actuate the moving contacts and to insure full contact pressure up to the time of opening, whether actuated automatically or manually. Automatic release is secured through the action of a bimetallic thermal element, which engages the releasing latch of the mechanism. The bimetallic material has been selected with great deal care to insure a constant calibration and to withstand short-circuits far in excess of actual requirements. The contacts are of especially-developed, non-welding material to prevent freezing under the short-circuit conditions to which the device may be subjected.

High rupturing ability of the automatic circuit breaker is secured through the application of the Deion principle. The moving contact, in opening, passes through a slot in a series of metallic plates insulated from one another, so that the arc is drawn through a relatively narrow passage and its heat is dissipated through absorption by the surrounding metal plates. Upon passing through the quencher plates, the arc gases are expelled into an insulated expansion chamber. This chamber, formed by the base and housing, is de-



ASSEMBLY OF 15-AMP. DEION CIRCUIT BREAKER, WITH COVER REMOVED

signed to isolate the gases entirely from the branch circuit connections.

The thermal release element is designed to give desirable inverse time limit characteristics. At higher overloads the time limit becomes less and less, until instantaneous tripping is secured. The circuit breaker is enclosed in an insulated sealed housing to prevent tampering with the mechanism or calibration unless the complete unit is removed from the panelboard and the cover unsealed. This construction, combined with the trip-free handle, is to prevent blocking the mechanism in the closed position as well as to insure tripping at the normal and original setting.

Thermo Hydraulic Feedwater Regulator

THERMO hydraulic feedwater regulator, designed to embody many new and improved features, has just been announced by the Bailey Meter Co., Cleveland, Ohio.

Figure 1 shows the regulating valve used in this new regulator; the valve is designed to be tight seating and fully balanced and has V-ports. In operation, it is claimed that these features obviate danger of flooding boilers at low rates of steaming or when on bank, provide smooth, continuous feeding of boilers while in normal operation and give a positive, non-chattering action of the regulating valve.

If seats must be reground or replaced, the entire valve cage can be removed from the regulating valve without removing the valve body from the line. The old cage, or a new one, can be replaced in the valve body with the assurance that all moving parts will be in perfect alinement, since the entire balanced valve mechanism is contained within the cage. This method of construction is used to eliminate the necessity of removing the entire valve body and machining the seat after it has been installed.

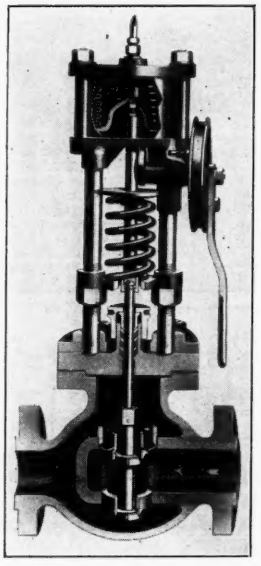


FIG. 1. VIEW OF INTERNAL MECHANISM OF REGULATING VALVE

In this valve, recessed rings in the valve cage, immediately below the valve seat, are used to prevent cutting of seats and valve discs by wire drawing at the tips of the V-ports. By means of these rings the flow

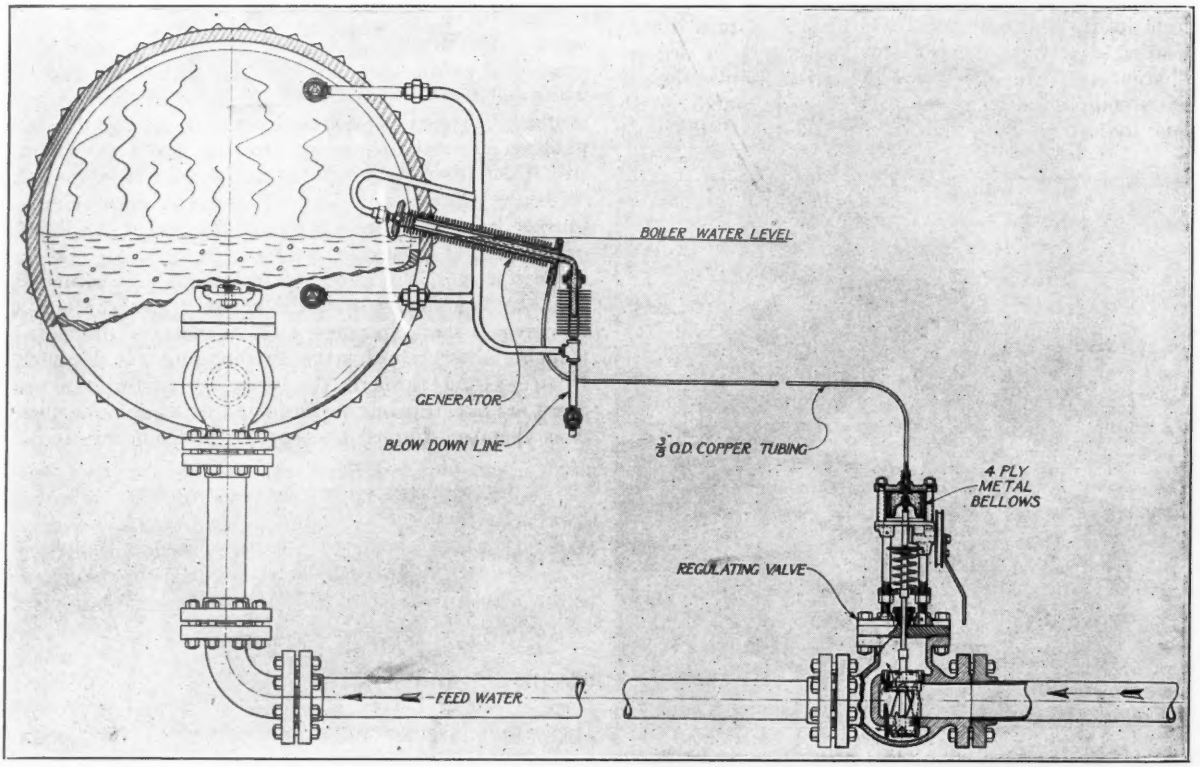


FIG. 2. DIAGRAM SHOWING PARTS AND METHOD OF OPERATION OF THERMO HYDRAULIC FEEDWATER REGULATOR

is evenly distributed so that equal wear occurs on all parts of the seat when the valve is operating near the closed position.

A lever and cam are provided on the regulating valve so that in case it ever becomes necessary to regulate feedwater by hand, the regulating valve can be quickly opened by a half turn of the bypass lever. For installations where the valve will be located at a considerable distance above the operating floor, a sheave wheel is provided on the valve so that it can be bypassed by a cable operated from the operating floor.

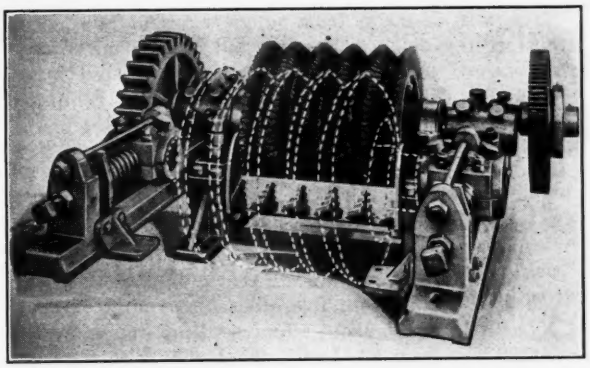
New features incorporated in the Bailey thermo hydraulic generator, which is located at the boiler water level, Fig. 2, are a cold water storage leg, a condensate bypass and a vacuum seal. The cold water storage leg, together with a large fin area on the generator tube, is designed to assure rapid condensation of steam in the annular space between the inner and outer generator tubes and, in turn, to result in positive closing of the regulating valve as the boiler water level tends to rise. Condensate that forms in the connecting piping between the generator and the boiler drum is returned to the boiler by means of condensate bypass, to prevent erratic and false operation of the regulating valve, which might be caused if the condensate were allowed to drain back to the boiler through the generator. The vacuum seal is provided to cause instantaneous closing of the regulating valve in case the boiler water level ever exceeds the upper limit of variation allowed by the generator.

Bailey thermo hydraulic feedwater regulators will be furnished in all pressure standards up to and including 1350 lb. There are no limitations as to where the regulating valve must be installed in the feed line, since only a hydraulic connection is necessary between the sylphon on the regulating valve and the annular space between the tubes of the generator. This connection is made of ⅜-in. o.d. soft annealed copper tubing, as is shown in Fig. 2. As will be noted, the annular space between the outer and inner generator tubes, the copper tubing and the 4-ply metal bellows or sylphon on the regulating valve, form an all-metal closed system. This system, because of its metal-to-metal ground joints is practically leakproof, it is stated, and seldom, if ever, must be refilled.

Triplex Crusher Incorporates New Design Features

DESIGNED to meet the increasing demand for smaller, more uniform coal, the new Triplex crusher shown here has been recently developed to be used in conjunction with stokers or pulverized fuel. Triplex, as the name implies, means that the crusher, in effect, is designed to combine three crushers in one. This is brought about by utilizing the two-roll crusher principle and by adding a wedge-shaped breaker plate below and between the rolls. While no actual new principles are involved, many new features of design have been added. Known and proved advantages of the ordinary roll type crusher have been retained and elaborated upon.

Capacity of the Triplex is intended to be practically three times that of single and double-roll crushers for the same size roll and peripheral speed. To secure this capacity, two outlets are provided instead of one and the orifice is zig-zagged in such a manner as to add approximately 40 per cent to its length to provide 2.8 times the output of an ordinary crusher for the same size product at the same speed.



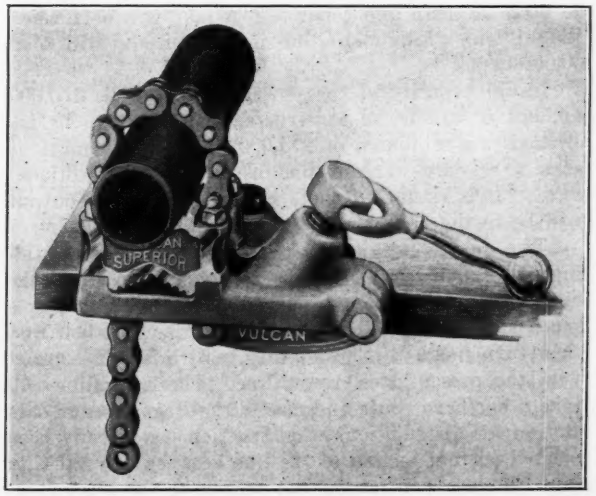
TRIPLEX CRUSHER WITH CASE REMOVED SHOWING HOW TWO-ROLL CRUSHER PRINCIPLE AND WEDGE-SHAPED BREAKER PLATE ARE COMBINED

Large run-of-mine lumps are readily nipped, it is stated, due to the deep circular corrugations on the face of the rolls. Crushing action, after the primary crushing, is increased because of the opposing crusher faces moving at different speeds, the differential speeds causing a tearing action.

The new Triplex crusher is a product of R. H. Beaumont Co., 319 Arch St., Philadelphia, Pa., which is issuing a new bulletin giving details and specifications.

Vulcan Superior Chain Pipe Vise

VULCAN SUPERIOR VISE recently placed upon the market by J. H. Williams & Co., Buffalo, N. Y., is designed for two advantages: overhead adjustment, the handle being on top and reversible jaws for longer life, as when the teeth first in use wear, the bolts can be unscrewed and the jaws turned over.

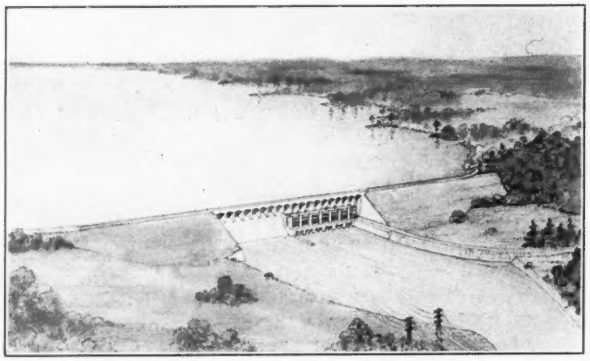


VULCAN SUPERIOR VISE IN USE

The vise is made from tough wrought steel, with drop-forged base, jaws, handle and chain-arm. Chains are designed to be unbreakable, compact, rapid in action, positive in grip. The vise is attractively finished in chrome-plate and furnished in two sizes for ⅛ to 4½-in. pipe.

Osage River Development to Cost $30,000,000

AT A POINT about five miles upstream from Bagnell, Missouri, about 40 mi. south of Jefferson City and 150 mi. from St. Louis, the Union Electric Light & Power Co. will build a hydroelectric generating plant



AN ARTIST'S DRAWING OF THE OSAGE RIVER DAM AND POWER PLANT OF THE UNION ELECTRIC LIGHT & POWER CO.

on the Osage River. The project has been made possible through the completion of negotiations involving the sale of the Mississippi River and Bonne Terre Railway to the Missouri-Illinois Railroad and the leasing of the latter line to the Missouri Pacific Railroad, the purchase of the Rivermines steam power plant of the St. Joseph Lead Co. and signing of a power contract with the company for its total electrical requirements of 150,000,000 kw-hr. per year.

The dam is to be built on a site now owned by the Missouri Hydroelectric Power Co. The dam will be approximately 2500 ft. long and 100 ft. high and will be built of earth and concrete. A lake will be formed 125 mi. long with a shore line of 1400 mi. and will flood 60,000 acres.

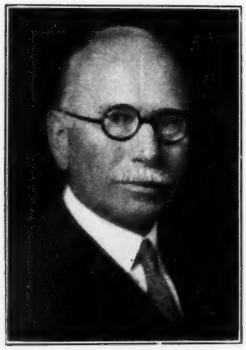
Initial capacity of the power plant will be 160,000 hp. but it will be so constructed that this can be increased to a minimum of 215,000 hp. should conditions at a later date warrant the installation of additional units. It is estimated that the average annual output will be in the neighborhood of 420,000,000 kw-hr.

Two double circuit, 132-kv. transmission lines, totaling 350 mi. in length, will be constructed to carry the output to the St. Louis district. One line will take a southern route, heading directly for the lead belt and then turn north to Crystal City, where it will connect with the present steel tower line. The other line will take a northern route and run to the Page Avenue substation for distribution. Construction has already been started on that section of the line between Crystal City and Rivermines in order that service to the Lead Company may precede the completion of the dam.

It is estimated that the total project will cost in excess of $30,000,000 and will require 2 yr. to complete. The reservoir, dam and power house will cost $20,000,000 and the transmission lines and substation, $10,000,000. Stone & Webster Engineering Corp. has been employed as designers and constructors of the project.

Death of Henry W. Wendt

HENRY W. WENDT, president of the Buffalo Forge Co., died of pneumonia at his home in Buffalo, N. Y., on June 12, aged 67 yr. During his entire business life he had been connected with the company, which was established in 1878 by his brother, the late William F. Wendt. Henry W. Wendt was educated in the public schools of Buffalo and joined the Buffalo Forge Co. when he was 16 yr. old. Later he became works manager and in 1910, when the company was incorporated, he became vice-president and treasurer and in 1916 was elected president. He was prominently identified with heating, ventilating and air conditioning work, had been



Blank & Stoller, Inc.

HENRY W. WENDT

president of the American Foundrymen's Association of Fan Manufacturers, was one of the founders of the Hydraulic Association, and a member of the American Society of Heating & Ventilating Engineers and the American Society of Mechanical Engineers. He was also president of Buffalo Steam Pump Co., The Geo. L. Squier Mfg. Co. and The Canadian Blower Forge Co.

Second National Meeting of the Oil and Gas Power Division, A.S.M.E.

STANDARDIZATION of Diesel engine operation, rating and costs, with a view to providing a definite basis for analysis and comparison of Diesel power with other motive powers was a dominant feature of the discussion at the oil and gas power conference held at The Pennsylvania State College, June 24-27, 1929.

Movements of outstanding character, which are expected to add much to the oil power industry, were initiated in reports on Diesel power costs, on Diesel fuel oil specifications and on standardization of oil engine ratings. All of these were introduced for the first time. Standing committees will carry on this work for yearly

presentation of results and recommendations at subsequent national meetings of this division.

Sessions were arranged for topical discussion of oil power problems thus bringing together those interested in different phases of the broad subject at different times. At the first two sessions, high speed engine topics were discussed. During the third session, some of the results of the Penn State Oil Spray research obtained during the year were reported. Costs were discussed at the fourth session. Early American development of Diesel engines was the topic of the principal speaker at the banquet and standardization was the theme of the last session.

One of the pleasing and profitable features of the conference was the ample amount of time scheduled for recreational purposes, which also permitted unusual opportunity for contacts and interchange of ideas.

Over 250 persons, many of whom had availed themselves of Pennsylvania's fine roads and beautiful scenery by coming by automobile, attended the meeting and visited the laboratories in which oil power investigations are being carried on. A more complete report of the proceedings will be published in the next issue.

News Notes

GRISCOM-RUSSELL CO., New York, has established a new sales office in the Lewis Bldg., Portland, Ore.

O. H. ESCHHOLZ has been appointed manager of the patent department of the Westinghouse Electric & Manufacturing Co., East Pittsburgh, Pa., succeeding O. S. Schairer, who resigned to accept a similar position with the Radio Corporation of America. Mr. Eschholz is a graduate of the Duquesne University Law School, Pittsburgh, Pa. and of Worcester Polytechnic Institute. He entered the employ of the Westinghouse Company in 1910.

STEPHENS-ADAMSON MFG. CO. of Aurora, Ill., announces the appointment of H. W. Newton, who for several years has been designing engineer for the company, as district manager of the Birmingham, Ala. district with offices at 1108 Martin Building, Birmingham.

AMERICAN ENGINEERING CO., Philadelphia, Pa., has received an order for 47 of its one and two-ton Lo-Hed monorail electric hoists from the Chesapeake and Ohio Railway Co.

HAROLD R. HENDERSON has been appointed advertising manager of the Brooklyn Edison Co., Inc., effective June 15. Mr. Henderson has been a member of the Brooklyn Edison advertising department since 1924 and has been assistant advertising manager for the last three years. Before coming to Brooklyn, he served for five years as advertising manager of the New Bedford Gas and Edison Light Co., New Bedford, Mass. He succeeds Fred B. Pitney, who died on May 20, 1929.

ANNOUNCEMENT IS made that the Cleveland office of the General Refractories Co. since June 1 has been located at 1126 Leader Bldg., Cleveland, Ohio. The Buffalo address of the General Refractories Co. has also been changed to 1210 Genesee Bldg., Buffalo, N. Y.

WILLIAM G. MARSHALL, since 1926 director of personnel for the Philadelphia Company and affiliated corporation, on July 1 became assistant to Vice-President T. P. Gaylor of the Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa. Mr. Marshall will be in charge of employes relations but it is announced that no change is contemplated in existing positions of director of personnel or manager of employes service. Mr. Marshall is a graduate of the University of Pittsburgh Law School and was associated with the law offices of Burleigh & Challener in trial work for the Pittsburgh Railways Co., joining the adjustment department of the Philadelphia Company March, 1916.

DEARBORN CHEMICAL CO., Chicago, Ill., announces that Edward C. Brown has been elected vice-president and eastern manager of the company and will have charge of the New York office and eastern department. Mr. Brown, who has been with the company 30 yr., has

EDWARD C. BROWN

been foreign manager in charge of the Buenos Aires office of the company for the past 16 yr. He has been succeeded at Buenos Aires by W. M. Campbell, who has been his assistant there for several years. Grant W. Spear, who has spent his business career with the Dearborn Chemical Co. and for the past 20 yr. has been vice-president and eastern manager, is retiring from active business but will remain a director of the company and act in advisory capacity, retaining his large interest in the business.

AS A SUPPLEMENT to its line of electric arc welding equipment, the General Electric Co. announces a clamp type electrode holder. This device has jaws of heavy copper alloy, notched to hold firmly any size of electrode wire from $\frac{1}{16}$ to $\frac{1}{4}$ inch in dia. in any position. A molded compound handle protects the operator from heat and from contact with current-carrying parts. The holder is designed for use with currents up to 300 amp.

WILLIAM S. HALLOWELL, for nearly half a century an officer of the Cochrane Corp. and its predecessor, the Harrison Safety Boiler Works, died at his home in Germantown, Philadelphia, on June 2. He was actively associated in the introduction of the Harrison safety boiler and the Cochrane open heater and, at the time of his retirement a few years ago, was secretary and treasurer of the Cochrane Corp.

AMERICAN HOIST & DERRICK CO. of St. Paul, Minn., announces that since June 1 its Chicago office, formerly at 1113 Fisher Bldg., has been located at 1000 Engineer-

ing Bldg., 205 W. Wacker Drive. The Pittsburgh branch is now located at 901 Farmers Bank Bldg. instead of 604 Chamber of Commerce Bldg.

BUNDY STEAM TRAP CO., Nashua, N. H., announces the appointment of W. W. Miller, Tulsa Trust Bldg., Tulsa, Okla., and C. L. Worthington, 724 Third Ave. North, Birmingham, Ala., as exclusive Bundy representatives in their respective localities.

PENNSYLVANIA PUMP & COMPRESSOR CO., Easton, Pa., has appointed as its agent for the Republic of Mexico the firm of Wells Fargo & Co., Express, S. A. Apartado Postal, 361, Mexico City.

CONSOLIDATED ASHCROFT HANCOCK CO., INC. announces that its general sales office has moved from New York to Bridgeport, Conn., effective July 1. The company also announces that G. A. Binz has been appointed assistant to the vice-president in direct charge of industrial sales research. W. P. Bradbury has been appointed general sales manager and N. B. Carlton has been appointed western sales manager in Chicago.

OLIVER AMES, senior member of the board of directors of the General Electric Co., died at his home in North Easton, Mass., on June 18. Mr. Ames, 65 yr. old, had been a member of the board since 1893, being elected at that time to fill the vacancy caused by the death of his father, who, previous to the formation of the General Electric Co., was a director of the Thomson-Houston Co.

O. C. MERRILL, member of the American Society of Mechanical Engineers, has resigned as executive secretary of the Federal Power Commission and on July 1 became head of the American section of the World Power Conference.

IT WILL doubtless grieve many of our readers to learn of the death of George Armitage, for many years chief engineer of the Traymore Hotel at Atlantic City, N. J. Mr. Armitage, generally considered the dean of the operating engineers at this resort, was an active N. A. P. E. member and was widely known also in the vicinity of Philadelphia and Chester, Pa. The vacancy created by Mr. Armitage's death is being ably filled by his son, John Armitage, who has for several years past been acting as his assistant.

GEORGE F. MOSHER, auditor of disbursements, was elected assistant treasurer of the General Electric Co. at a recent meeting of the board of directors of the company, it has been announced by R. S. Murray, treasurer.

ACCORDING to a recent announcement, the Westinghouse Electric and Manufacturing Co., East Pittsburgh, Pa., has now actively entered the heat exchanger field. The experience which this company has obtained in the design and manufacture of heat transfer equipment for power plants and other industries is now to be applied to the building of heat exchangers for every application and, particularly, heat exchange apparatus for the oil industry.

The Westinghouse line of heat exchangers includes coolers, fractional condensers and final condensers for low and high pressure service. These vary in size from very small units to those containing several thousand square feet of surface. All apparatus is designed especially to meet the specific conditions of each installation, insuring the greatest economy. In order to secure greater flexibility, Westinghouse heat exchangers are usually furnished in multiple units and installed in battery arrangement.

MAY SALES of mechanical stokers as reported to the Department of Commerce by the ten leading manufacturers in the industry totaled 174 with 60,772 hp., as compared with 141 of 48,748 hp. in April and 130 of 38,706 hp. in May, 1928.

Books and Catalogs

CODE OF MINIMUM REQUIREMENTS for Heating and Ventilation of Buildings, 1929 edition, published by the American Society of Heating and Ventilating Engineers, 29 West 39th St., New York City; bound in loose-leaf binder, 6 by 9 in., leather cover, 158 pages, price $5.

The code, containing 14 sections in separate pamphlets, is the result of many years of effort by L. A. Harding of the Society and his committee, and as published is the culmination of 5 yr. work. Its purpose is to standardize as far as practical, the installation of heating and ventilating equipment. It is intended to represent minimum requirements as called for by good engineering practice and is written so that it may be incorporated as part of a municipal building code if found desirable. It is prepared in loose-leaf form to permit revision from time to time to keep pace with engineering development. The various sections cover minimum requirements for ventilation for public buildings, estimating heat required for warm buildings, determination of direct steam and hot water radiating surface for various systems, low-pressure steam and hot-water heating boilers and warm air furnaces, chimneys or stacks, pipe sizes, air ducts, ventilating fans, air washers and filters, pumps and so on. An appendix gives formulas and tables of engineering data and standard symbols for heating and ventilating drawings.

COMBUSTION, a new magazine, which replaces the old one of that name, made its bow with the July 1 issue. It will be published monthly by the In-Ce-Co. Publishing Corp., a subsidiary of International Combustion Engineering Corp., to advance standards of fuel utilization and steam generation. Carl Stripe is editor, R. C. Denny, technical editor, and Charles McDonough, business manager. In the 33 editorial pages of the July issue are articles on Heat Absorbing Surfaces for Boiler Furnaces, Industrial Steam in Great Britain, Heat Balance Test and Matching Fuel Equipment to Coal by R. J. S. Pigott, David Brownlie, B. J. Cross and T. A. Marsh.

IN BULLETIN No. 52, The Dust Recovering & Conveying Co., Harvard Ave. and East 116th St., Cleveland, Ohio, reprints the article entitled "Trenton Channel Station Eliminates Powdered Coal Dust from Cyclone Vents." IN BULLETIN No. 53 is described how Dracco system is applied to coal drying in connection with coal grinding operations.

ZELNICKER'S BULLETIN No. 383, containing lists of material for sale, such as tool steel, railroad material, machine tools, air compressors, boilers and engines, has just been issued for May, 1929, by Walter A. Zelnicker Supply Co., 511 Locust St., St. Louis, Mo.

SAFETY IN WELDING, the most recent industrial publication of the Policyholders Service Bureau, Metropolitan Life Insurance Co., New York City, is based on a study of welding practices and presents the outstanding health and accident hazards involved with suggestions for overcoming them. Effects that various light rays exercise upon the body and methods of protecting against such rays are discussed in detail. This study has been made and published for officials of organizations in which welding has become an important operating process or where welding is used as a medium of maintenance and repairs. Copies will be sent to such officials upon request to the Metropolitan Life Insurance Co.

IN A WELL ILLUSTRATED bulletin, Yarnall-Waring Co., Chestnut Hill, Philadelphia, Pa., describes the floatless, Hi-Lo alarm water column and Sesure inclined water gages. Cross section of the column is shown and detailed drawings of the alarm operating mechanism which practices on the displacement principle, while the inclined or vertical gages are shown with round or flat glasses, as desired. The bulletin shows both gray iron and forged steel water columns, screwed and flanged for all working pressures up to 1400 lb.

ELESCO Multiple-Loop Single-Pass superheaters are interestingly described and illustrated in Bulletin T-19 issued by The Superheater Co., 17 E. 42nd St., New York, N. Y. The special feature is the forged sharp return bend with enlarged area in the bend and extra thick walls which allow extending units into the hottest furnace zones. Copies of the bulletin will be sent on request to the company.

MATHEMATICAL TABLES AND FORMULAS, by Percey F. Smith and William Raymond Longley; First Edition, 5 by 7¾ in. Flexible cloth, 66 pages; John Wiley & Sons, Inc., New York, 1929; price, $1.60.

Convenient tables and formulas arranged to save time and relieve the memory of students and engineers. Tables of squares, cubes, square roots, cube roots, reciprocals, trigonometric functions, logarithms and mathematical formulas are included.

MAN'S CONQUEST OF THE AIR, an article by Stig G. Sylvan, research engineer, Midwest Air Filters, Inc., and Prof. Samuel E. Dibble of Carnegie Institute of Technology, is being issued in bulletin form by Midwest Air Filters, Inc., Bradford, Pa. This discusses in a technical manner the principles and developments of dust elimination and the practical application to the building of commercial air filters that have been made of these principles.

BULLETIN NO. 16, Edition No. 1, containing data on lubricating equipment has just be issued by Wm. W. Nugent & Co., 410 N. Hermitage Ave., Chicago, Ill. The bulletin describes and illustrates sight feed valves, sight feed oilers, capillary oilers, sight flows, alarms, pipe fittings, valves, oil cups and other equipment needed for lubricating all types of machinery.

WIDE RANGE of uses of electric arc welding in the maintenance field is shown pictorially in publication D.M.F. 5156 recently issued by Westinghouse Electric & Manufacturing Co., East Pittsburgh, Pa. This folder, entitled "Maintenance by the Electric Arc," is No. 7 of a series of folders on arc welding which may be had on request.

INTERNATIONAL PURIFIERS for gas and steam are described in a recent bulletin No. 106. This discusses first the principles of purification of vapor containing liquid impurities and shows how these principles are applied in the design of the International purifying element. Construction of the International purifier is described and illustrated in detail with detailed sketches, tables of dimensions and capacities and other engineering data. The International pressure discharge system for steam purifier service is described and information is given on the use of this system with automatic boiler blowdown in proportion to the moisture content of the steam generated. The bulletin is issued by International Filter Co., Inc., 333 West 25th Place, Chicago, Ill.

FITTING CONSTRUCTION PROCEDURE to Modern Requirements is the title of a bulletin just issued by Morton C. Tuttle Company, engineers, Boston, Mass. This discusses some of the factors that must be considered in constructing industrial and commercial buildings and discusses the methods used by Morton C. Tuttle Co. in doing this.

CENTRIFUGAL AIR COMPRESSORS, their construction and their application are described in bulletin A-50, issued by the Allen Air Appliance Co., Inc., 452 Lexington Ave., New York.

POSSIBILITIES of reducing steam costs in the average pulp and paper plant are discussed in a reprint, Paper Mill Steam Plants Keep Up with the Times, showing improvements made in recent years in the design of fuel burning and steam generating equipment. Copies of this article will be sent upon request made to Combustion Engineering Corp., 200 Madison Ave., New York, N. Y.

UEHLING COMBINED BAROMETER and Vacuum Recorder to enable turbine operators to know their absolute back pressure at all times and its relation to the highest possible with the barometer pressure then existing is described and illustrated in a 6-page bulletin No. 150 issued by the Uehling Instrument Co., 473 Getty Ave., Paterson, N. J.

SAFETY WATER COLUMNS for high and low pressure, high and low water alarms, Tiltview water gages, gage cocks, floats and gage glass protectors are fully described, illustrated and proper installation described in Catalog R-1929 issued by The Reliance Gauge Column Co., 5932 Carnegie Ave., Cleveland, Ohio. It is a handsome and instructive compendium on water column practice.

IMPROVED JONES SIDE DUMP STOKER is completely described in a recent 24-page illustrated bulletin by Riley Stoker Corp., Worcester, Mass. The bulletin gives complete details regarding the principles on which the stoker operates, illustrates and describes all its parts, shows the new mechanically driven unit and the steam driven unit, together with the Riflex mechanical drive, recently developed for this stoker. Illustrations of the Jones stoker as installed in all types of power plants are given at the end of the bulletin, together with a list of representative installations.

COMPLETE TECHNICAL DATA, photographs, layout diagrams, and tables of sizes and ratings of a variety of equipment are discussed in several recent new bulletins of the General Electric Co., Schenectady, N. Y. Bul-

letin GEA-517B describes totally enclosed, fan-cooled d.c. motors, type CD, 2 to 51 hp. shunt and compound wound. Across-the-line starters for induction motors, known as CR7006-F1 magnetic switches, are described in bulletin GEA-1106. G-E induction frequency converters for furnishing power to high-speed motors at higher than normal frequencies are discussed in bulletin GEA-750A. Station oil circuit breakers for 7500 to 220,000 volts, are described in GEA-926A. Metal-clad switchgear, single-phase capacitor motors, squirrel-cage motors for sugar centrifugals, Novalux constant-current transformers and geared centrifugal compressors are described in other bulletins. In leaflet GEA-1095, ground clamps for outdoor stations are described.

In a 24-page, well illustrated bulletin, No. G-1, Steam Jet Ejectors are discussed by Elliott Co., Jeannette, Pa. The complete line of ejectors, as made by this company, is described and applications to all kinds of service are shown, especially for industrial process work involving the use of vacuum.

Type "O" Oil Switches and Circuit Breakers are described in bulletin No. 600 by Roller-Smith Co., 233 Broadway, New York City. These are of a new type designed for 200 to 2000-amp. capacities at 2500 to 15,000 v., with interrupting capacities of from 20,000 to 40,000 kv-a. The bulletin illustrates the various parts of the breakers, gives tables of capacities and details of applications.

Chicago Pneumatic Vertical Gas Engines, type RHG 75 are described and illustrated in bulletin 782 of the Chicago Pneumatic Tool Co., 6 East 44th St., New York City. General construction of the engines is shown by photographs and cross section drawings, and the various parts are completely described and illustrated.

Houghton on Industrial Plant Lubrication is the title of a 56-page attractively illustrated booklet recently prepared by the Research Staff of E. F. Houghton & Co., Third, American and Somerset Sts., Philadelphia, Pa. Types of lubrication necessary in industrial plants are discussed and the bulletin then presents data on Houghton's Absorbed Oils and their uses.

Bulletin No. 1170, recently issued by The Dampney Co. of America, Hyde Park, Boston, Mass., illustrates and describes various types of power plant equipment to which Apexior coatings are applied for the prevention of pitting and corrosion. The booklet also shows the equipment perfected by the company for applying these coatings quickly and uniformly to the internal surfaces of bent and straight boiler tubes.

Type "L" feedwater heaters designed for capacities of 500 to 500,000 lb. per hr. and for use where minimum space and weight requirements must be considered, are described in a leaflet sent out by Schutte & Koerting Co., 12th and Thompson Sts., Philadelphia, Pa.

Baffling for Straight Tube Boilers is interestingly discussed and various types described and their application shown in an article by Walter Seigerist of the Combustion Engineering Corporation, 200 Madison Ave., New York, N. Y. This article is published by the Corporation and copies may be had on request.

In a 12-page, well-illustrated folder, the Type D, Model M, Venn-Severin Oil Engines is described. This is a two-cycle, two-cylinder engine designed to start from cold with the aid of a small electric heater, with packless fuel injection pumps of non-corrosive metals, extremely rugged mechanical construction and arrangement for obtaining two-stage combustion. The bulletin illustrates the various parts of the engine, shows its principle of operation and other features. The engine is also made in a four-cylinder type. The catalog is issued by the Venn-Severin Machine Co., Chicago, Ill., as bulletin No. 400.

Cash Standard Auxiliary-Operated Valve, Class G Main Valve Class P. Auxiliary, is described in bulletin No. 924 recently issued by A. W. Cash Co., P. O. Box 135, Decatur, Ill. The valve is made in sizes from 1 to 10 in.

Lubrication of Steam Turbines with Nonpareil Turbine Oil is discussed in an illustrated bulletin issued by Technical Division, Lubricating Department of the Standard Oil Co. of Indiana, 910 So. Michigan Ave., Chicago.

Ashcroft Power control valve is described in bulletin No. 1525 of the Consolidated Ashcroft Hancock Co., Inc., 100 East 42nd St., New York, N. Y. The function, design, capacity, construction and operation are described and illustrated. This valve, actuated by steam pressure and an electrical circuit will operate to open and close on a one per cent difference in pressure at a pressure lower than that of the pop safety valves, thus saving wear on those valves as well as blowoff steam.

Whiting Tiger Cranes for industrial service are described in bulletin No. 188, an attractively illustrated, 24-page bulletin by Whiting Corporation, Harvey, Ill. Detailed description with illustrations is given of the various parts of the crane, such as the herringbone gears, bearings, oil-cooled mechanical brake, bridge drive and structural features.

Code for Electricity Meters; Third Edition, size 6 by 9 in., flexible cloth, 122 pages; National Electric Light Association, New York, 1928.

This edition of the code is a complete revision of the second edition published in 1912 and the section on Demand Meters issued in 1920. The code is the accepted standard for meter practice.

The Use of Hydroelectric Units as Synchronous Condensers, publication 289-66, has just been issued as a serial report of the Hydraulic Power Committee, Engineering National Section, National Electric Light Association, 420 Lexington Ave., New York City. The report states that owing to the demand for better voltage, better power factor and better service conditions, use of hydroelectric units as synchronous condensers is coming to be the accepted practice in the hydroelectric field. The report records the general experimental results and economic conclusions of a number of operating companies that have equipped their hydroelectric plants so that the units can be used as synchronous condensers. Detailed discussion is given of the equipment and methods used by one company in doing this, since these methods are considered typical. A detailed questionnaire was sent to all southern hydroelectric companies that were using generators as synchronous condensers and the report contains a comprehensive tabulation of the practice of the various companies in this respect. The report was compiled by Frank M. Nash of the Carolina Power & Light Co.